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The Institute Paper. THE last paper read at the Institute of Electrical Engineers was one of an eminently practical kind which, when properly presented, should be and are as welcome at those meetings as papers of a theoretical or purely scientific character. It describes a new and very interesting insulating material called "micanite," consisting of thin laminae of mica laid over each other, each piece covering the joints of those below it and secured together under great pressure by means of cement. The amount of cement being extremely small, the insulating material is practically all mica and therefore possesses to a great extent the very valuable insulating and refractive properties of this material. But in addition it has the great advantage that unlike natural mica sheets it can be made to conform to any shape required and will retain its form, which quality makes it especially applicable to armature insulation. Furthermore any size of sheets can be made, while with natural mica the size is of course very limited. The only objection to this paper as read was its somewhat ill-advised original title, which, however, we are pleased to see has since been changed by the author and it now represents the true contents and adds to rather than detracts from its value.

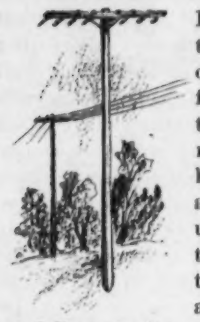
Electrical Disinfecting. SOME weeks ago we referred in these columns to the possible advantages of using electrically ozonized air as a germicide, more especially in connection with cholera epidemics, but there are also other methods for preparing disinfectants by cheap electrical processes which may appeal to the public more directly, because instead of the refreshing ozonized air, they involve the use of liquids, which are malodorous, a quality which the public have unfortunately become accustomed to associate with all effective disinfectants to such an extent that now a disinfectant may almost be defined as something, which smells worse than the odor of the other poisons in the air. The process which we refer to is that which has long been known as the Hermite process in which a current of electricity is passed through a chloride solution developing in it hypochlorides, which are powerful disinfecting agents. This process has already been in use largely for bleaching paper, and is, therefore, nothing very new, but its recent introduction at Havre and Rouen, in France, for preparing disinfecting solutions to be used in connection with the cholera epidemics appears to be a new use. The installation required consists simply of a steam engine, a dynamo, the electrolytic bath and a pump. The ordinary sea water is pumped through this bath and is collected in storage tanks. Unfortunately, no figures of the cost are at hand, but in a case which concerns the protection of a large country like this from the introduction of an epidemic of cholera, the expense, which would probably be small, in this case, ought to play no part whatsoever.

Electrical Standards. A FINAL report of the Board of Trade Electrical Standards Committee has been issued. The provisional recommendations, it will be remembered, were given out more than a year ago, and at that time were published in THE ELECTRICAL WORLD. The interval between the two reports has been made use of in endeavors to secure the internationalization of the fundamental electrical units, the co-operation of Prof. Helmholtz, Dr. Guillaume and Prof. H. S. Carhart having been practically pledged for this purpose on behalf of their respective countries. The resolutions contained in the new report are for the most part identical with those originally agreed upon. In accordance, however, with the recommendations of the British Association Electrical Standards Committee as announced in our columns at the time of the British Association meeting last August, the mercury column standard is now defined in terms of its weight of a definite length and the same constant cross-section, while the voltage of the Clark cell is now specified as 1.434 volts instead of 1.433 volts. In addition it is also specified in this latest report that the standard ohm should from time to time be verified by comparison with the mercury column instead of with the B. A. ohm. The greater part of this final report is occupied with minute directions regarding the use of the silver voltameter method of standardizing the standard current instrument and regarding the setting up of the Clark standard cell. We are informed that the Board of Trade is expected to immediately take the necessary steps for securing the legalization of these standards within the British Empire.

Transmission of Power from Coal Fields. THE introduction of the electrica transmission of power was naturally followed even in the very earliest days of the development of electrical engineering, by suggestions of various possible applications in the future. Even before motors were generally introduced it was suggested to convert the power of Niagara and that of coal at the mines into electrical power and transmit it to the industrial centres. The former proposition is at present being carried out, and it is safe to say that it is only a question of time when the latter also will no longer be a suggestion but an established fact. The promising success of the Niagara Falls plant in this country has had the good effect of stimulating such colossal enterprises, as the idea of converting the coal into electrical power at the mines and transmitting it to the industrial centres is now apparently receiving earnest attention in England, judging from a paper readat Manchester. In this paper, of which we publish an abstract, the author, Mr. Thwaite, describes a proposed plant worked out in some detail, which cannot fail to appeal to one as being in general quite rational and practicable, although the success of the plant as proposed will depend in a great measure on the important question whether alternating current motors and large gas engines are sufficiently well developed at the present time to justify their use on such a large scale. Among the interesting features of the plant is that, instead of using steam engines to convert the energy of coal into electrical power, he proposes to use gas engines, because he claims these to be more economical, and because. n making gas, valuable by-products are obtained; both of which are evidently very important considerations. The cost of coal delivered at the boilers in our large manufacturing cities is said to be about double that at the mouth of the mine, which, put in technical language, means an efficiency of 50 per cent. in the transmission of the power of the coal, for transportation of coal on cars may correctly be considered to be one form of the transmission of power. There is no doubt that an electric system of transmission would yield more than 50 per cent.; it would be a very poor one if it did not at least do that, the question is only, would the gain be worth the cost of the enormous installations required. But the matter of efficiency is only one feature and possibly not the most important one, as in many cases it is outweighed by the economy of the consumers paying only for the power used, and by the fact that local steam power plants in factories requiring so much space and a great outlay of money, will then be no longer necesary. Mr. Thwaite's plan is well worth the attention of Americans, as such a scheme, if practicable in England, ought also to be so here.

Motors Without Counter E. M. F. UP to not very many years ago, the inventor who had a dangerously small amount of knowledge in mechanics wasted much of his time in inventing useless perpetual motions, most of which, according to the inventor, would have run had it not been for some fault which he did not understand. As this occupation of inventing perpetual motions is now no longer a profitable one, many of these inventors have turned their attention to electrical subjects. To those who know little or nothing about this subject its mysteriousness makes it a very attractive field in which they may invent prolifically and waste their time and their friends' money almost without limitation. Our attention has frequently been, and is even to day, called to electrical inventions of this class, which, like many perpetual motion devices, show great ingenuity which is absolutely wasted, resulting only in disappointment and costly experience. Sometimes the fruitless endeavors of these inventors are due to the want of a knowledge of the first principles, in which case a small amount of study would probably have shown them the uselessness of working in that direction. Sometimes, however, it is due to their refusing to recognize well established laws and fundamental principles which intelligent men have accepted all the world over; in such cases nothing less than costly, discouraging experience and sometimes years of wasted time and labor will convince them—if they can be convinced at all—that they had better not butt their heads against a stone wall. Among other electrical inventions on which much time has thus been, and is being, wasted, is that of designing an electrical motor having no counter E. M. F. Owing probably to misleading statements in so-called text books, many persons have obtained an idea that the counter E. M. F. of a motor is an inherent fault which ought to be corrected by radical changes in the design, and which, if done away with, would result in a revolution of the motor industry. That modern motors having a counter E. M. F. almost equal to that on the mains, have an efficiency in the nineties ought itself to be sufficient to convince any fair minded person that as far as efficiency is concerned radical improvements are no longer possible, but as this does not appear to be a sufficiently good proof for some minds, there is another way of looking at the problem which may, perhaps, make the matter clearer. The electric power delivered to a motor may, for simplicity, be divided into two parts, omitting that small part which is due to friction losses, eddy currents and hysteresis. One of these, is what is generally termed that C^2R part and the other the Ce part; the first represents that which is consumed in the resistances of the wires; this is irrecoverably lost in heating the motor and, of course, the smaller it is the better. The second part, which is the product of the current and the counter E. M. F., is that part which is converted into the useful work of the motor, as may readily be shown by theory as well as by actual experiment; therefore the greater this part is made the better, because it means that the motor is capable of doing just that much more work; as counter E. M. F. forms a part of this, it ought evidently to be made as high as possible. As these two parts make up the whole, it is evident that if the one increases the other diminishes and therefore if by any device, be it ever so ingenious, the counter E. M. F. is diminished, or appears to the inventor to be entirely absent, it follows beyond any doubt that the C^2R part will be increased no matter whether the inventor thinks so or not, and the motor will necessarily be very inefficient. If the inventor does not believe this he will find it out when he runs his motor. A motor with little or no counter E. M. F. is therefore of little or no use in exact proportion, and the sooner these principles are accepted by such inventors the better it will be for them and their capitalists.

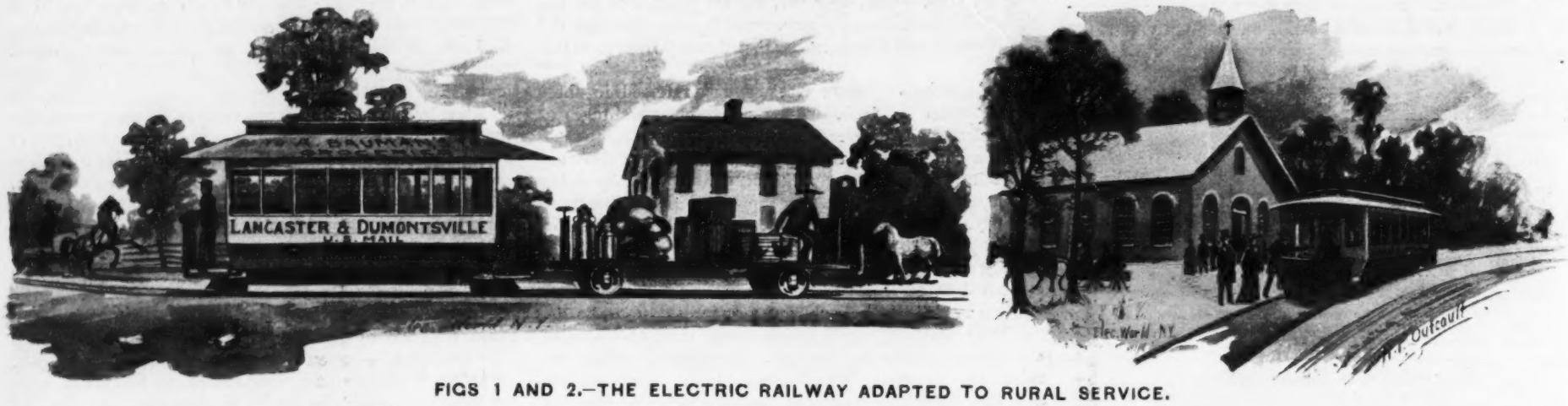
Applications of Electricity to Agricultural Work.—IV.



HE general adaptability of the electric motor for service in various kinds of farm work has been discussed in former papers, and a number of illustrations have been given, showing methods of applying electricity to the hoisting and pumping apparatus, and to a number of miscellaneous machines used in ordinary farm work. It remains to discuss in this article the application of electricity to moving machines and vehicles. It may be well to follow up the original outline of this subject and consider the three heads, viz.: (1) Railway lines on country roads; (2) tramways connecting farm buildings, and (3) miscellaneous vehicles, such as carriages and field machines of all kinds to which electricity is now considered or may ultimately be found to be applicable.

In our first article reference was made to the articles on the subject of electric railways for country roads, by Wm. Nelson Black, which have appeared in the columns of The Electrical World. A general discussion of this subject was contained in these articles. Some illustrations are given herewith, showing what services such a system of country roads might, in certain localities, be expected to furnish. One of the illustrations shows an electric road in a country district utilized for the transportation of lumber from the saw-mill in the vicinity. In this case, electricity also furnishes the power for the operation of the sawmill, a work which, of course, is not unusual for the electric motor. A number of instances where electricity is used for the operation of sawmills have been described and illustrated in our columns, the most striking of which was probably that in use on the World's Fair grounds at Chicago, where no less than eleven different sawmill plants were in use, driven from current supplied from a single central station.

Another instance of what might be expected of the electric railroad running through country districts is shown in a second illustration on this page. Here, among other things, the road is used for the transportation of farm produce to a large county institution. Establishments of this kind are usually large consumers of products raised on the neighboring farms, and it is almost always the case that they are so situated that all sorts of transportation, both to and from the institution, must be done by horses and wagon. It very often happens that boys' industrial schools, for instance, are not only large consumers of produce that must be hauled in from the surrounding country, but are also in turn producers of a great variety of manufactured articles that must be transported, usually by primitive means, to the nearest steam railway station. Our illustration has been made from the consideration of an actual location of an institution of this kind in one of our western states, which will doubtless be recognized by many of our readers. Electric railways running through country districts would, of necessity, be equipped for both freight and passenger traffic, and in considering the question of the actual profits upon an investment in roads of this kind, it must be borne in mind that although at first, even perhaps in the best localities, only a sufficient business would be obtained to pay for the investment, nevertheless, the increased facilities offered for the rapid and frequent transportation of passengers and freight would lead, ultimately, to a very greatly increased business of this kind. Not the least point to be considered is the use that could be made of roads of this kind for the transportation of United States mails, and for their rapid and frequent delivery in country districts. As soon as the isolated character of the farm gives way to a service of communication between the larger towns and cities that shall be rapid and frequent, just so soon will the proverbial congestion of the great mass of our population in large cities be supplanted by a more nearly equal and uniform distribution of the people throughout the best parts of the country.



FIGS 1 AND 2.—THE ELECTRIC RAILWAY ADAPTED TO RURAL SERVICE.

Nothing has here been said about the importance of electric railways running through the country as feeders to the steam roads already established, and which would, in hundreds of instances that might easily be pointed out, be converted by this method from non-dividend paying properties into profitable investments. This is a subject which has recently claimed the attention of the public to a very large extent in connection with the agitation now going on for what has been rather indefinitely called "good roads." There is indisputable proof that good roads are regarded by the best informed railroad men as an advantage to the steam railroad, simply because wherever they exist they open lines of travel and transportation which ultimately become feeders to the steam railroad. If this is true of the ordinary macadamized road, there is no doubt about its being true of the electric road, which might be constructed for less money over the same route.

The great additional advantages to be obtained by the construction of a tramway over a country district in preference to a macadamized road are that transportation would be much more rapid, that the road would be more serviceable to a greater number of people and could be used for a greater variety of purposes, and that, in addition to its service as a line of transportation, it would be able to furnish to farms along the line whatever power was necessary for stationery machines. This business of the general distribution of electric power in country districts for performing work that is now done by man or beast would ultimately become not only of the greatest importance in the development of the country, but a most profitable source of revenue to the company. An opportunity for ascertaining to just what extent service of this kind will be called for will doubtless be furnished upon the completion, in the not distant future, of the electric railway line between Chicago and St. Louis. Whatever variety of current, alternating or direct, may be used in the operation of this road, the distribution of power by direct current of the proper voltage will be entirely feasable, and indeed the company's prospectus shows that it is counting upon this business to produce for it, ultimately, a very large revenue. If multiphase currents are used, motor transformers can be called into service for transforming the current of the railway companies' feeders into that needed on the motors used in the farming districts.

It is unnecessary to discuss to any great extent the introduction and use of electric tramways for the purpose of connecting the different buildings on some of the large western farms. Work of this kind would be identical with this class of service now so admirably performed by electric tramways in mill and factory yards for transporting either the raw material or the finished product. Current for these tramways could be taken from the lines of the electric railway connecting the different farms, and the amount consumed could, of course, be determined and charged for by using any one of the well-known forms of electric meter.

Leaving tramways aside, a word is necessary regarding the electric carriage for the ordinary macadamized or common country road. Some of these have already been constructed and operated with success in different parts of the country. Ordinarily a motor is attached to the carriage, to which current is supplied by storage batteries carried under the seats. Carriages of this kind would, of course, be entirely practicable in country service, and the batteries could be charged from any suitable source.

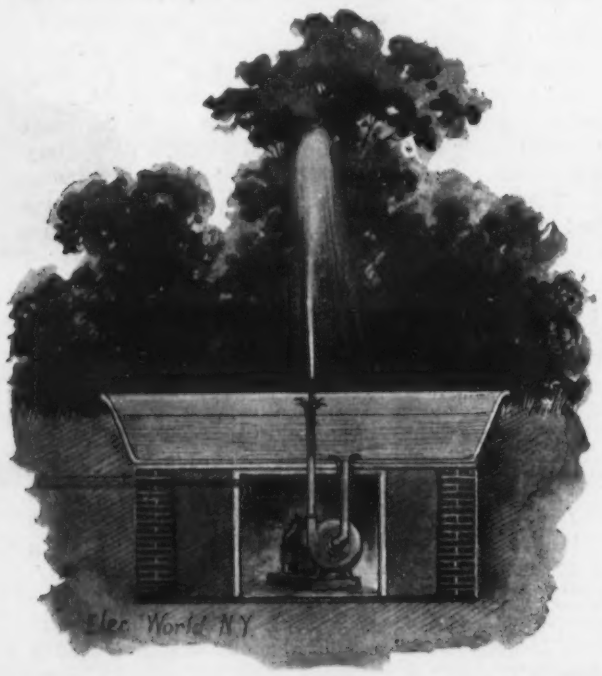


FIG. 3.—AN ELECTRIC FOUNTAIN FOR THE COUNTRY.

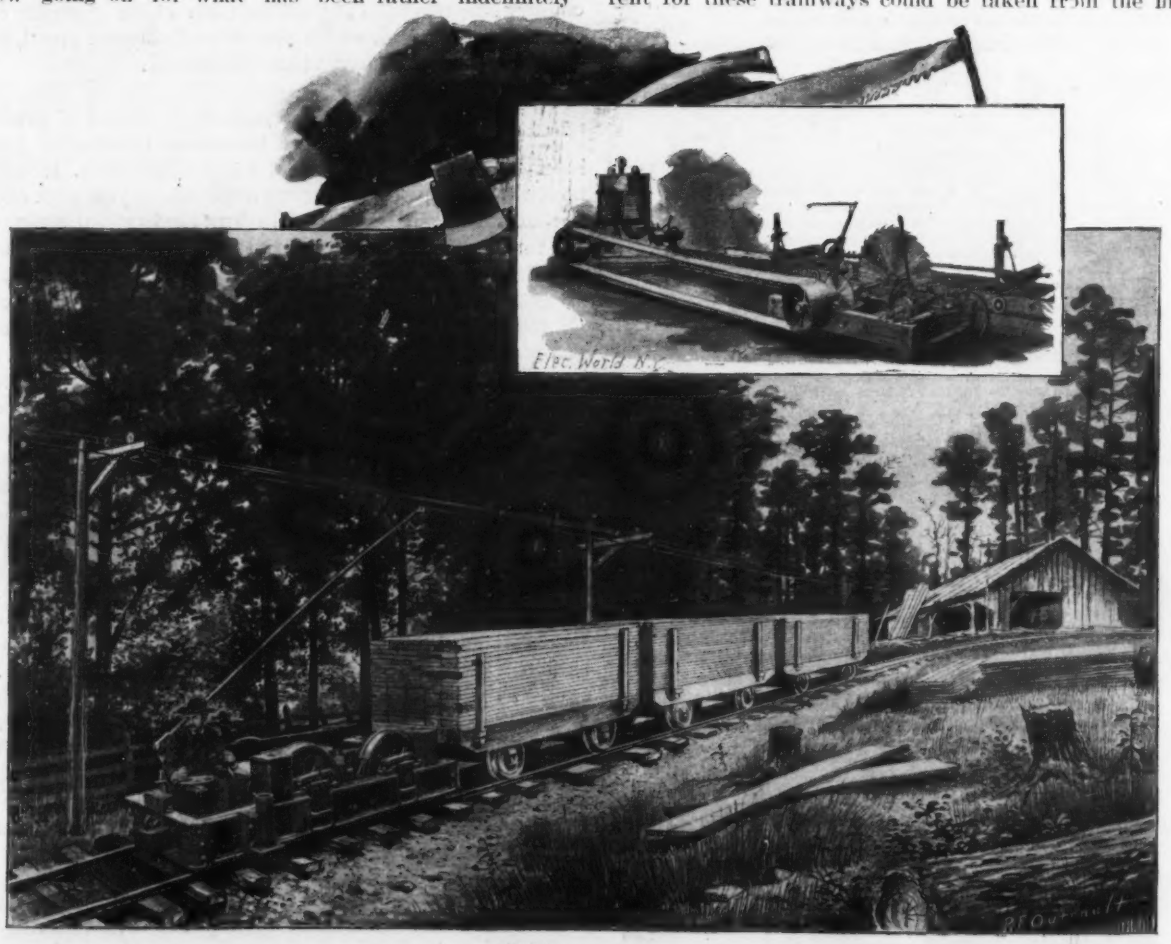


FIG. 4.—A COUNTRY TRAMWAY, SHOWING ONE OF ITS USES.

Electricity at the World's Fair.

(*From Our Special Correspondent.*)

Progress of the Work on the Installation of the Exposition Power Plant.—The foundation for the engines in the exposition power plant are nearly all completed, that of the E. P. Allis 500-h. p. engine which is direct connected to the Westinghouse railway generator and that for the General Electric Company's combined 1,000-h. p. engine and dynamo being the only ones yet to be finished. The foundations for the electric power generators and for such of the dynamos as do not rest directly on the wood floor are also completed.

The line shafts for the dynamos in the arc light plant are being rapidly put in place and the largest of these, that for the 100-h. p. Russell engine which is to drive twelve Standard dynamos, is already in place. It will be understood that these line shafts are located under the main floor in the basement, and that the engines and dynamos are belted through the floor.

Some few of the engines are already in place, and others are continually being received and set up. None of the large engines, however, for the incandescent dynamos have yet arrived, although the Allis 200-h. p., the Buckeye, Atlas and Fraser & Chalmers 1,000-h. p. engines are all expected to be on hand next month, and will be immediately erected.

Most of the arc dynamos are now in the storerooms on the Exposition grounds, but will not be set in place until the authorities are ready to operate them. It is the expectation, however, to have a portion of the arc lighting plant in operation by the middle of January, which will include the Russell and some of the Buckeye engines, driving Standard and Fort Wayne dynamos.

Of the boilers, the Root and Gill are practically completed, as are also two batteries of the Babcock & Wilcox and one of the Heine. Of those remaining the iron work is all erected and the brickwork is being rapidly pushed to completion.

The main 36-inch steam headers are finished, and all except the two in the Boiler House Annex are in their places under the visitors' gallery, and most of these are lined up on their foundations. The boiler connections to the headers are being now put in place, and some are up except for a few closing lengths. The main supply and overflow pipes for the condensers are nearly all on the grounds and will soon be in place. Some of the smaller pipe connections are also ordered for those engines which will first be put in operation.

The Wiring of the Buildings and Grounds.—As to the wiring for the lights, some of the buildings are completely wired, among which are the Art, Woman s and Administration buildings, besides several minor ones. These three are the only ones of the large buildings that are to be lighted entirely with incandescent lights. The other large exhibition buildings are lighted with arc lights, except in the offices and smaller public rooms. These office lights are now being installed. The converter pits are all located and the ducts for the incandescent wires mostly in the ground.

On the exterior lighting of the buildings around the Canals and Grand Basin but little has as yet been done, although the illumination of the Administration Building is almost finished. The arrangements for arc lighting on the grounds are also being rapidly completed. The ducts are all in place and the posts are now being set. Although not much wire for this work has as yet been run, it will soon be pushed rapidly.

Altogether the work is well on in a fair stage of completion and the prospects are very encouraging that when the gates are opened to the public on the 1st of May the electric lighting plant will be fully equipped and in perfect running order.

The Sunday Closing Question.—The Sunday closing question has assumed a new and interesting phase. To understand the matter clearly, we must go back to last October when the World's Fair authorities granted to a certain line of steamers the sole right to land passengers at the wharf at the Fair Grounds. At this time the South Shore Transportation Company, comprising various steamship companies doing business at the foot of Van Buren street, applied for an injunction against the law to prevent their landing passengers at Jackson Park, the South Park Commissioners, the Illinois Central Railroad and the World's Columbian Exposition being made defendents. On Monday, Dec. 19, the plaintiffs' attorney, John C. Simonds, appeared before Judge Tuley, and asked leave to amend the petition. In addition to the application for an injunction to restrain the complainants from landing at the grounds, the amendment reads: "And from closing Jackson Park on Sunday, and on said day excluding the public and your orators from the use of said park on Sunday, as the public and your orators have a right to use said park, subject, however, to the payment of an entrance fee to the Fair, the same as is charged for each and every day of the week."

It is claimed that the South Park Commissioners hold this property in trust for the people, and that neither they nor the United States Government can give the use of the land to any corporation to the exclusion of the people. It is also claimed that the Southtown and Hyde Park residents have

FIGURE TYPIFYING THE TELEGRAPH—A DECORATION OF ONE OF THE WORLD'S FAIR BUILDINGS.

been heavily taxed for the improvement of Jackson Park, and that they cannot be excluded on Sundays.

In regard to the landing of the boats the point is made that the World's Fair Committee, which gave the privilege to a private corporation, cannot discriminate and prevent the complainants from unloading their boats at the park.

Judge Tuley allowed the amendment prayed for, and this brings up the question of Sunday closing in an entirely new light. The motion will be taken up early in January, and the outcome will be watched with interest by both sides.

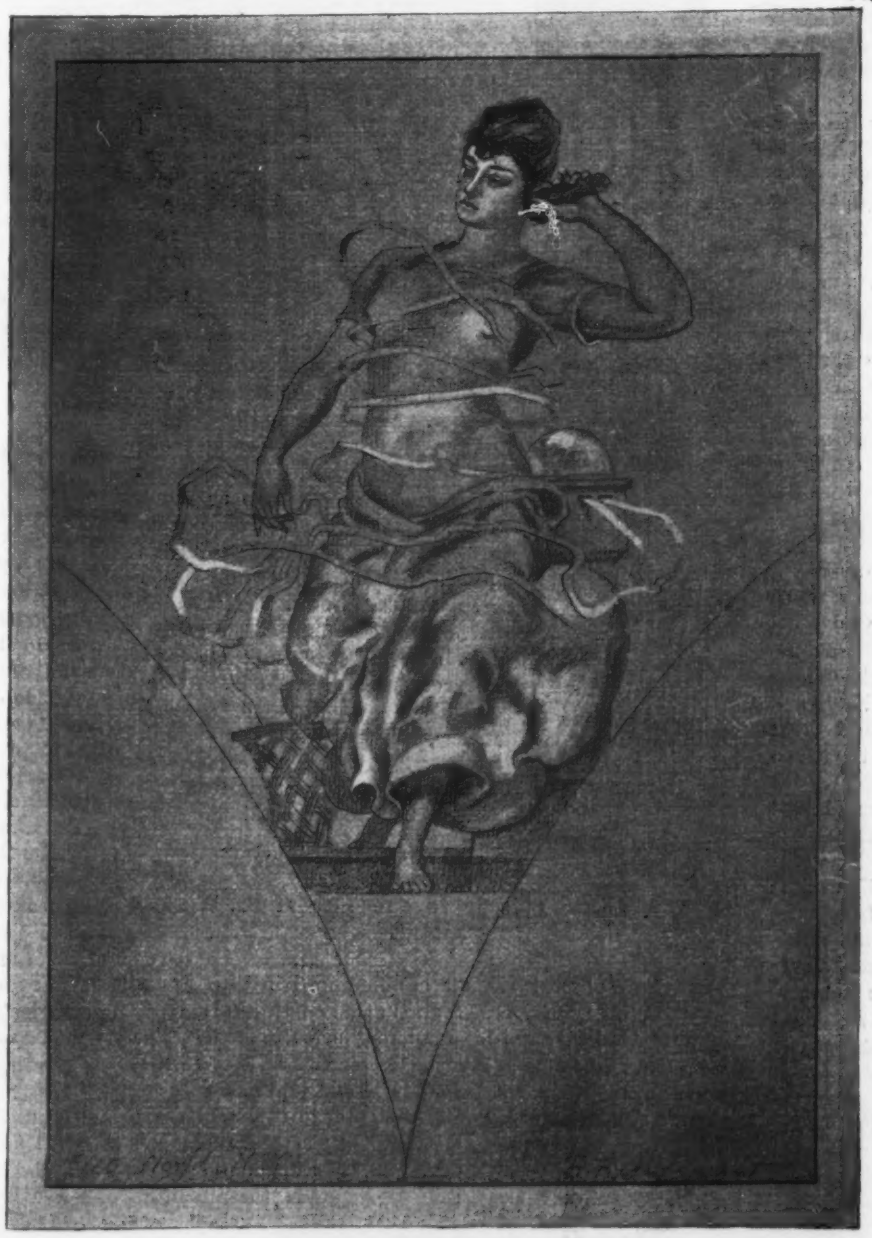


FIGURE TYPIFYING THE TELEPHONE—A DECORATION ON ONE OF THE WORLD'S FAIR BUILDINGS.

The Conkey Contract.—An affair that has caused the World's Fair officials considerable annoyance has been brought, as far as they are concerned, to a happy conclusion. Some time since they advertised for bids for the printing of the official catalogue of the Exposition, and the contract was finally let to one W. B. Conkey. It developed afterward that Conkey employed in his establishment non-union labor.

Typographical Union No. 16 awaited upon the committee who had the matter in charge to protest against the award to a non-union establishment, and, fancying that they had not received due attention, made threats that if the award was not withdrawn that all union labor at the Fair Grounds would be called out, and work in all departments brought to a standstill. Further than this, they claimed that some of the World's Fair officials were themselves pecuniarily interested in the contract, and Commissioner St. Clair was named as one of those so interested. The latter, of course, demanded an investigation, and a most thorough one was instituted, with the result that he was entirely exonerated—not only that, but it was conclusively proved that not the slightest suspicion of venalty or self-seeking had been cast upon the commissioners, the directors or upon any of the officials of the Exposition.

Their accusers were challenged to produce the evidence upon which they had made the charge, but produced nothing, thus virtually admitting that they had no ground to stand on. Later, Mr. Conkey, in order to avoid trouble, agreed to pay union prices in his shop, and on Tuesday Mr. Askew, of the Typographical Union, appeared before the commissioners and read a paper signed by the president of the Trade, and Labor Assembly and the president of Typographical Union No. 16, both of whom were present, withdrawing their protest against the award to Conkey and also the charges of corruption against the commissioners, and stating that they were satisfied from the explanations made that none but strictly honest business methods had been adopted in making the award.

The Souvenir Coins.—The matter of chief interest in World's Fair circles last week was the arrival of the first installment of 50,000 of the souvenir coins. Treasurer Seeberger, of the World's Fair, had been notified that they had been shipped from the Mint, at Philadelphia, via the United States Express Company, on Friday night, Dec. 16, and although they could not possibly have arrived before Saturday night, the World's Fair headquarters, in Rand-McNally building, were besieged all day Saturday with inquiries after the coins. They arrived safely, however, early Sunday morning, consigned to Sub-Treasurer Tanner, and were stored at once in the vaults of the United States Express Company, on Washington street. They were unpacked in bags, 10 in number, each containing 5,000 coins, and these were inclosed in kegs, two bags to the keg. On Monday morning they were duly delivered to the sub treasury, where one of the kegs was opened by Cashier Whittemore, the contents of one of the bags counted and the remaining bags weighed and a receipt given for the full 50,000. Later in the day they were turned over to President Higinbotham, who had them transferred to the World's Fair headquarters. One of the kegs was marked "Special." This he opened, and among others found the first, the four-hundredth, the fourteen-hundred-and-ninety-second and the eighteen-hundred-and-ninety-second coin minted, each inclosed in a separate envelope, together with a certificate of its number.

The first coin, for which the Remington Typewriter Company had bid $10,000, after having been placed in a silver frame was duly delivered to Mr. John F. McClain, the authorized representative of the Remington Company. Mr. Higinbotham placed the treasurer's seal on the wax that held the lid of the box which inclosed the coin, and thus ended the formality of transfer of the highest priced coin ever minted.

The distribution of the coins to early subscribers commenced early Tuesday morning. The new coin comes fully up to expectation and is a beautiful specimen of die work, clear cut and well defined. In size it is a shade smaller in diameter than the current half dollars, but contains the same weight of silver. The edges are sharply milled, and on the face is a medallion of Columbus. Surrounding this in clear cut letters are "United States of America" above and "Columbian Half Dollar" below, the two inscriptions being separated at either end by a single star.

The reverse side bears a fac-simile of Columbus' vessel with all sails set, and beneath it the two hemispheres separating in the middle the date 1492. In an arc of a circle above the vessel are the words "World's Columbian Exposition," and at the bottom beneath the two hemispheres is the date 1892.

Decoration and Illumination of the Electricity Building.—The only decorations provided by the management for the interior are the statue of Franklin, of heroic size, and the medallion of Morse, both of which will probably be placed at the south end, and the painting of the pillars and the ceiling, or roof, which are tinted a delicate blue. It is said that this is the first instance on record where the interior of a temporary exposition building has ever been painted and decorated in such a complete manner.

The Allotment of Space in the Electricity Building.—The allotment of space in the Electricity Building at the World's Fair and the arrangement of exhibits has at last been completed, and workmen are now engaged in marking out on the floor the bounds of the various allotments. By special arrangement we are enabled to lay before our readers, in advance of official publication, the relative positions of the various exhibits.

As is probably known, the roof of the Electricity Building is supported by two systems of arches at right angles to each other, forming a longitudinal and transverse nave, which, crossing in the centre of the building, form at that point a ground arch, giving the general appearance to the rectangular building of a Gothic style of architecture.

Across both ends and extending for 320 feet to the transverse nave are the galleries, which are 115 feet wide, and in the aggregate comprise 95,000 square feet of floor space, exclusive of the two restaurants, which occupy the two deep bays, 115 by 57 feet each, at the north front of the building. These galleries are reached from the ground floor by eight flights of broad stairways—two flights at the end of each nave.

The business offices of the Electrical Department, now occupied by Prof. Barret and Mr. Hornsby, are situated at the extreme southern end of the building, on the gallery floor, and are irregular in outline, to conform to the shape of the great recess, 100 feet high, which marks the main entrance to the building.

The ground floor, covering an area of 250,000 square feet, or about 5½ acres, has been laid out in two main aisles 18 feet wide, running north and south, and two of the same width running east and west, the four coming together at a 30-foot circle in the exact centre of the building beneath the ground arch.

In addition to these there are on either side of the main north and south aisles, two others of lesser width, the ones nearest the sides of the building being 9 feet wide and the intermediate ones 10 feet. The former terminates at the toilet closets, which are located beneath the stairways at the ends of the transverse nave, and the latter extends a little further toward the centre of the building, and is terminated in all four cases by portions of the Edison General Company's exhibit in the transverse nave.

The general arrangement of the exhibits may be said to conform to the roof lines, or to follow the axes of the two naves, that is, they form a well defined cross, with its two longer arms extending north and south, and the two shorter ones lying east and west, and then the remaining space is filled in. Having pictured this arrangement to ourselves, it will be easy to locate the various exhibits, taking the central point as our place of departure.

The 30-foot circle in the centre of the building has been assigned to the Phœnix Glass Works, which will erect a structure of glass 70 feet high. Just what the nature of this structure will be has not been divulged, but it will presumably be something very handsome, as it has been the policy of the administration to assign the choicest places to those who will make the handsomest exhibits, and this is certainly the post of honor.

Also in the centre of the building will be found the exhibit of the General Electric Company, as well as Mr. Edison's personal exhibit. The remainder of the southern arm is made up of the exhibits of the Detroit Electrical Works and the American Bell Telephone Company, which brings us to an area in front of the south entrance. The southwest corner has been assigned to the Brush Electric Company, the Swan Lamp Company, the Short Electric Railway Company and the Fort Wayne Electric Company, and against the walls at the south end commencing at the doors are located the Jenney Electric Motor Company and the Crocker-Wheeler Electric Company. Along the west wall will be found, commencing at the south, the Hanson Company, the Germania Electric Company, the National Electric Company and the Electrical Engineering and Supply Company, the latter being located next to the south toilet rooms at the west end of the transverse nave.

The southeast corner in like manner has been divided between the Western Electric Company, the Westinghouse Electric and Manufacturing Company and the Excelsior Electric Manufacturing Company, and against the wall at the south end, commencing at the door, will be found the C. & C. and Sperry Electric Mining Machine companies, and on the east wall the La Roche, the Hornell Iron Works and Eddy Electric companies, which brings us again to the toilet closets at the east end of the transverse nave.

The northern end of the long arm of the cross is completed by the French exhibits, which also occupy the deep bay at the northwest corner of the building and also considerably more space in the northwest corner. France has by far the largest space of any of the foreign countries. The remainder of the northwest corner is taken up by England, whose exhibit, by the way, is divided, the remaining portion being in the southeast corner of the northwest gallery. The Thomson Electric Welding exhibit adjoins England's on the west.

In the northeast corner, directly across the aisle from the French exhibits, are the major portion of the German exhibits. These, too, are divided, the remaining portion being upstairs in the southwest corner of the northeast gallery.

The bay at the northeast corner of the building is occupied by the Zucker & Leavitt Chemical Company, the Ricker Electric Motor Company, the Perkins Lamp Company, the Jewell Belting Company, and the Akron Electric Company.

The east wall, commencing at the north and going south, is occupied by The E. S. Greeley & Co. and the Page, Munson and Schlerin belting companies. Between these and the main German exhibit will be found, beginning at the north, A. S. Mather, the Arnold Electric Company, F. C. Phillips, the Belknap Motor Company and the Electrical Forging Company at the south, next to the toilet rooms.

This completes the down-stairs assignments. In the galleries they have not yet been fully decided upon, but ascending either of the stairways at the north end of the building, we come to the two restaurants, which occupy the whole of the two bays, each being 115 feet by 57 feet The two are connected together by a broad balcony 30 feet wide, which runs across the north end of the building.

In the southeast corner of the northwest balcony, overlooking the General Electric Company's exhibit, is the additional English display, and adjoining this to the north, at the outside edge of the balcony, will be found that of Canada. The additional German display is directly opposite the English, in the northeast gallery.

Each of the four galleries has in its centre a well, 160 feet long by 25 feet wide, to admit light to the exhibits below, and the space is divided by four aisles, three of which are nine feet and one eight feet wide.

The Ward Twin Arc Lamp.

The use of the arc light on incandescent circuits is coming more and more into popular favor both for inside lighting and the illumination of streets and areas. Its advantages are now so well known that the field of its application is very rapidly enlarging. The twin lamp shown in the accompanying illustration is peculiarly adapted for this class of work, and its manufacturers have been very much gratified at the success which it has attained.

WARD ARC LAMP.

This lamp consists essentially of two Ward lamp mechanisms, placed together in series, so as to use the same frame and same globe—in short, two lamps in one globe—and is designed for use in ordinary 110-volt incandescent circuits. This arrangement combines the good points of two separate lamps, without many of their objectionable features.

Heretofore it has been necessary, when arc lamps were employed for this purpose, either to insert dead resistances in series with one lamp, or use two lamps; the former arrangement means the direct loss of so much energy, the latter is often undesirable. In many, perhaps most, cases only one lamp is desired, and even where two would not be objectionable they do not always work satisfactorily together. Any defect in the burning of the one is strongly brought out by comparison with its companion. The twin lamp will give as much light as the two, and will concentrate it. It is a complete unit in itself, independent of all other lamps on the circuit. The "Ward" twin lamp consumes between five and six ampères, and gives a powerful light, which casts no shadow. With $\frac{7}{16}$-inch or ½-inch carbons, it will burn all night with its small consumption of current, which is a very important feature.

These lamps are manufactured by the Electric Construction and Supply Company, R. B. Corey, general manager, 16 and 18 Cortlandt street, New York City.

An Interesting Episode in the Life of Dr. Werner Siemens.

The death of Dr. Siemens was announced in THE ELECTRICAL WORLD of Dec. 17, and in that connection a recapitulation was given of his numerous services to electrical science and industry. An odd adventure of his earlier years, however, has come to our notice and seems to be worth placing on record. It seems that in 1840, while still in the Prussian artillery, he occupied the honorable but comparatively safe position of second in a duel and for this misdemeanor was sentenced to five years' imprisonment in a fortress. While in prison he occupied his time in scientific experimenting, discovering the art of electroplating, his rights in which he sold to a Magdeburg jeweler for 40 louis d'or. He was interrupted in his scientific work by the announcement of a pardon. He begged to be allowed to continue for a little while longer in prison to carry on the investigation he then had in hand. His request was considered by the authorities as an impertinence, and he was summarily expelled from prison at midnight. Not the least of Dr. Werner von Siemens' claims to renown and the gratitude of the scientific world was his donation of 500,000 marks in 1886 to the now famous Physikalische Reichsanstalt at Charlottenburg.

The Edison Lamp Litigation Continued in Pittsburgh.

Advices from Pittsburgh are to the effect that J. R. Smith, general counsel for the Edison Electric Light Company, has filed a bill in the United States Circuit Court, asking for an injunction to restrain the Westinghouse company from manufacturing and selling incandescent lamps that infringe the Edison patent. The present suit does not involve the new lamp being manufactured by the Westinghouse company, but refers only to the lamp which the Sawyer-Man company and the United States Electric Lighting Company were enjoined from making by a decree in the United States Court. The bill alleges that since the injunction the manufacture of these lamps has merely been transferred from the shops of the companies restrained to that of the Westinghouse company, which company controls the others. The court took the papers.

Interesting Reminiscences of Sir John Pender and Jay Gould.

Away back in those early "Eighties," says a writer in the New York *Recorder*, John Pender, M. P. at that time for some place in Scotland, arrived in New York. He was then, as I believe he is now, the "Cable King" of the British Empire. In addition, he is Sir John Pender, with the decoration of the Star of India and other orders. I was asked by the editor of a weekly journal to write a sketch of him, and a meeting was arranged for me at the offices of the cable company Mr. Pender controlled. They were on Broad street, just around the corner from Wall. My opinion of Mr. Pender is of no value. That he is a great, sagacious business man, financier and cable builder all the world of capital and electric invention knows. What he said is of more consequence than any estimate I may put into type. In this country Sir John Pender has never obtained the credit to which he is justly entitled for his share in the laying of the first Atlantic cables. On that subject this is the substance of what he said: Mr. Cyrus W. Field s a dear old friend of mine. I have had a delightful time with him at his farm up the Hudson, and we recalled old memories of our cable struggles so many years ago. I was in with him at the start and I lost heavily as he lost by the failure of the first attempt to bring the two nations into instant communication. "I well remember," said Mr. Pender, "the night he and I walked from my home to the House of Commons, when he came to London to raise capital to make the second attempt at electrically connecting the two continents. He did not have a great deal of capital behind him, but he was a very gold mine of enthusiasm and daring, and I promised to go with him again to the extent of £40,000, or, as you here count, $200,000."

There was some talk in financial and other circles at the time of Mr. Pender going into the Western Union directory, and I believe he did go in. Mr. Pender had been away out on the plains, and the special car in which he traveled having been hauled up at a "siding," the telegraph office of the Western Union company was entered to get the news. "I was then informed," said Mr. Pender, "of the great victory of our troops in Egypt under General Wolseley. I got news of the success, taking American time as the standard, ahead of the hour when the battle had been fought, and I wired General Wolseley my congratulations to Egypt from the midst of the American wilderness. The fact," said Mr. Pender, "that, through human agency that feat was possible of accomplishment, that in my case it had been accomplished, made a deeper impression upon my mind than I can describe to you. It was a miracle of human progress."

The incident naturally suggested the name of Mr. Gould, and to Mr. Pender I put the question, "What is your estimate of Mr. Gould?" The papers had told me that they had met.

"Mr. Gould," said Mr. Pender, "is the ablest, the most sagacious, the most far-seeing man I have ever met."

Ten minutes after Mr. Pender had spoken these words I saw Mr. Gould walking down Broadway along by Trinity Church. Crossing over from the head of Wall street we met near the main entrance of the building. He stopped and I opened the conversation in these words: "Mr. Gould, a few minutes ago I was with the Cable King of the old world, and now I meet the Telegraph King of the new one."

"You mean Mr. Pender," he answered, with the faintest perceptible smile.

"Yes," I replied, "and in the course of an hour's chat with him he spoke about you."

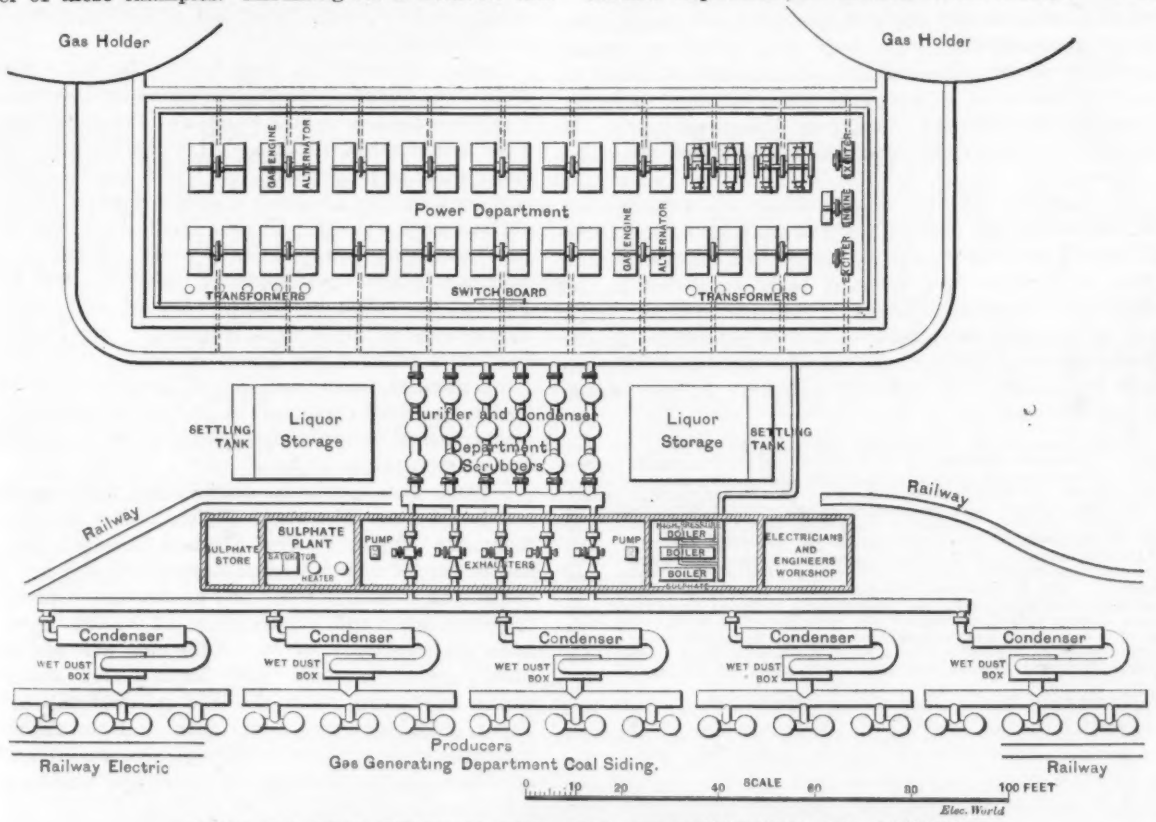
Mr. Gould became at once interested, and said: "Well, what did he say?" I repeated the words above quoted. He looked in at the tomb of Lawrence of "Never give up the ship" fame just inside the church railings. Two o'clock in the afternoon Broadway was thronged. Looking up suddenly he saw that fifteen or twenty people had stopped to look at him. His pallid face flushed a little, and he said: "Will you walk down to the office with me?" It was only a few steps away. I then told him about the Wolseley incident, and what Mr. Pender had said of Western Union, which seemed to gratify him very much. That conversation ended with his offer of a position to me on the *World;* after thinking it over, I declined.

Generating Power at Coalfields and Transmitting it Electrically to Industrial Centres.

In a paper read before the Manchester (Eng.) Association of Engineers, by Mr. B. H. Thwaite, C. E., on "Economic Possibilities of the Generation of E. M. F., in the Coalfields and its Application to Industrial Centres," the author reviews the general subject of the generation of power in manufacturing cities, and suggests a plan for converting the coal at the mines into gas, using this in gas engines for driving alternating current generators and transmitting the electric power to the industrial centres. The idea, in general, is the same that has been suggested frequently in this country, as a solution of the problem of the economic utilization of coal and the introduction of power generators in factories, more suitable and economic than the present steam engine. But the plan of Mr. Thwaite is more than a mere suggestion, it is worked out in detail and contains numerous points of interest; we, therefore, reprint here in the language of the original paper such portions as have a direct bearing on this subject.

Our coalfields have advantages that neither falling torrents of water, high tidal ranges, nor yet the force of wind currents possess. The supply of energy is constant, and does not depend upon the temperature of the one nor the barometric pressure and lunar dependence of the other.

Advantages of a Central Power Generating Station, or the Distribution of the Power from a Central Source.—The arguments that may be pertinently advanced in favor of a central power generating station are almost identical with those associated with the centralization of a gas and water supply, or a sewage treatment station, but the arguments are more adequate than those in favor of either of these examples. Assuming for a moment that



PLAN OF THE STATION FOR THE TRANSMISSION OF POWER.

the textile and other factories and workshops were all connected up with the power transmission mains conveying power generated at some large centralized power-generating station, the factory owner would not then have the anxiety and responsibility of his power plant, involving the care of the skilled and unskilled labor element. The space absorbed by the steam boilers and economizers, engine-house, coal stores, and chimney would not be required, and in towns this consideration might not be of unimportance. Then the troubles of coal and suitable water supply, and all the attendant requirements involved in the proper care and supervision of a steam-engine plant would be avoided. The boiler insurance question would not trouble him. He would, in respect to his motive power supply, be as free from care as the proverbial jolly miller, whose power came from the winds of heaven or from the falls of rivulet and stream. The waste of fuel in early lighting and during meal hours would be avoided, and the excess of labor almost always associated with the conditions of isolated and comparatively small steam-power plants would be saved. At the exact hour in the morning the mere movement of a switch throws the plant into operation, and at night the quick turn of a switch handle cuts off the power. The interest on the cost of the transmitting gear, the steam engine, the steam boilers, and the buildings during 14 hours out of the 24, which is at present lost, would, by the supply of power from a central generating station, be avoided. The same main service, with the addition to the electromotor of a transformer, would be available for lighting purposes, for elevating goods and traversing them, and for ventilating, fire extinction, electrolytic, and innumerable other purposes. In the event of a decision to stop the factory for an indefinite period, there is no expensive staff to maintain the plant in a condition of efficiency. Another feature is the fact that an additional extension, involving extra power plant, can easily be accomplished, whereas we all know how difficult in many instances it is to add extra steam-power plant, simply owing to the exigencies of space and position. The compactness of the electric generator machinery permits it to be placed in positions absolutely prohibitive for any other kind of power-generating plant. Besides these advantages, there would be no troublesome factory chimney belching forth its smoke to poison the atmosphere and defeat the beneficent natural laws involved in the cycle of the conservation of energy.

(Referring to the commission appointed some years back by the Birmingham Corporation to report upon the compressed air project, he stated that they tested a great number of engines in everyday work, and varying in power from 4 to 25 nominal horse power. The total fuel consumption was ascertained, as well as incidental or associated costs. Owing to the extremely intermittent and varying character of duty, the engines working under the most favorable conditions only averaged throughout the day one-third of their working capacity, but under the worst conditions only one-seventh of the maximum capacity was utilized. The coal consumption in the most favored examples was 8.5 lbs. per indicated horse power per hour upon the average daily horse power, and in the worst example the coal consumption attained the phenomental one of 36 lbs. per indicated horse power per hour.) The commission carefully state that these results are not due to the imperfect construction of the engines, but are consequent on the varying character of the work required, and the necessity imposed upon each power user of maintaining a plant and steam engine equal to his maximum requirements.

As an illustration of the advantage of central supply plants in lieu of isolated ones, and which will be still further emphasized, let us refer to one example. If there are 10 engines, each of 10 h. p., and each engine is required to work only one hour during a day of 10 hours, under the present system at least 100 h. p. of steam-producing plant would be necessary, whereas with a central power-generating station connected with each works it is quite possible, where the working hours are sufficiently distinct to adequately permit of an engine power equal to 20 h. p., to supply the wants of the 10 power consumers. The first consideration is to convert the thermic value potential into dynamic energy, and with as high a degree of efficiency as possible. The inevitable conclusion of everyone who examines the subject without bias will be that the procedure that will give this ideal method to fulfill the highest practical standard of efficiency and satisfy the exigencies of duty is as follows:

1. The conversion of the solid fuel into a gaseous condition.

2. The abstraction of the nitrogenous value from the fuel, and its conversion into a condition suitable for agricultural fertilization.

3. The direct combustion of such gaseous fuel in the combustion cylinder of a gas motor, for the conversion of the thermic into dynamic energy.

4. The transformation or transmutation of this dynamic into electric energy, or into E. M. F.

(A diagram was shown which gave with approximate accuracy the apportionment of the thermic capital supplied by a gas or a steam engine and its allocation for useful, effective work, and the loss by unavoidable dispersion by conduction, sensible heat, and as unexpended thermo-chemical assets in the waste gases.) The ultimate possible results of a fuel gas and gas motor plant on a large scale, is, that with such a plant, the dynamic power enclosed in the indicated card of pressure of a cylinder will be equivalent to the raising or elevation of 33,000 lbs. 1 ft. high in one minute may be obtained with an expenditure of from ⅝ lb. to 1 lb. of solid fuel—that the fertilizing value from this fuel should be equivalent to the supply per ton of fuel of the equivalent of the nitrogen to that contained in 22 lbs. to 28 lbs. or more of ammonia sulphate. At present these conditions cannot be economically obtained from any other form of motor-generating procedure or plant than a gas engine. The procedure of the steam-engine method has an associated loss far greater than the gas engine, and although it is possible to convert the fuel into a gaseous condition and recover the nitrogen, there are losses attending the employment of such a procedure that partly neutralize the gain. It must be obvious to anyone that direct and perfect combustion actually inside the walls of a motor cylinder must be more economic than the combustion more or less imperfect in the flues of a steam boiler, even if effected under the most favorable conditions.

Methods of Transmitting Power.—The practicable methods of transmitting power may be divided into three—firstly, the hydraulic; secondly, the pneumatic; and thirdly, the electric. For ordinary quick-speed work hydraulic transmission of power is not very suitable. Air or pneumatic power transmission is economically applicable for short distance transmission of small power. In the pneumatic system for forwarding light parcels, as adopted at the General Post Office, London, and at Liverpool, pneumatic transmission has its happiest application; but for comparatively heavy work, and distances over two miles, the loss of efficiency is most serious.

A motor of 500 h. p. is the largest that should be used for this character of work. The efficiencies of dynamos or electric generating machines are so nearly perfect that there is only questionable advantage in building excessively large types; but the motive power and elements should be such that if one or two parts go wrong it will not involve the arrestation of the entire motive power plant. Besides, it should be possible to reduce or increase the power of dynamic energy production in proportion to the demand, and with large steam engines of 1,000 h. p. and upward this would not be practicable. There is another and important advantage in relatively smaller power gas engines—the pulsations of piston effort could be so arranged that their effect on the supply would be inappreciable.

In the arrangement of the plant, Fig. 1, for the projected coalfield generating stations, gas motors of 300 b. h. p. are intended to be used, a pair of these engines being allotted to each alternating-current machine, coupled direct, one engine driving the armature in one direction, and the other field magnets in a contrary direction.

Cost of Energy to the Consumer.—Taking the report of the Birmingham Compressed Air Commission as a basis of computation, it appears that the majority of motive power plants did not exceed 20 h. p., and for all powers below this the cost may be taken to vary in the metropolis between £10 and £18 per annum per horse power. This amount covers the cost and depreciation of the engine and boiler, cost in repairs and lubrication, rent of land and buildings, insurance, coal, water, and labor. The cost of this energy delivered electrically, and including the hiring rates for motor transmitter, should not exceed £4 10s. to £5 for 3,000 working hours per annum; it is most probable that the figures will be less, so that if the charged for energy varies from £7 2s. for powers above £7 to £9 per horse power per annum, it would be a great gain to him, not to mention the lessened anxiety, and he could also arrange to pay for his power in proportion to the amount used. According to a letter from M. Emil Huber, of the Maschinen Fabrik Oerlikon, the price charged for energy varies from £7 2s. for powers above 10 h. p. and not exceeding 200 h. p., but for very small powers below 10 h. p. as much as £16 per horse power per annum is charged to the consumer.

Metallic Chromium Obtained by an Electrolytic Process.

In a recent number of *Comptes Rendus* Mr. E. Placet describes a new electrolytic process by which he has succeeded in obtaining pure metallic chromium, which has formerly been but a laboratory curiosity, and in some cases was not pure chromium at all, but merely a more or less pure carburet of that metal.

To an aqueous solution of chrome-alum he adds an alkaline sulphate and a little sulphuric or other acid. In electrolyzing this solution beautifully brilliant deposits of pure chromium are formed on the negative electrode. Its properties are as follows: It is very hard, has a bluish white color, resists atmospheric action, and is attacked only by concentrated nitric or sulphuric acid and concentrated solutions of potash. He said that this process may be applied on a commercial scale, which, if true, represents a very important step, as the alloys of chromium, notably those with iron and steel, are becoming of great importance.

He also states that he has succeeded in electroplating brass, bronze, copper and iron with any desirable thickness of an adherent deposit of chromium resembling oxidized silver. At the time of reading his paper before the Académie he showed specimens of pure metallic chromium weighing over two pounds, and also samples of chromium alloys and brass ornaments electroplated with chromium.

Chronological History of Electricity—Part II.—1800-1820.

BY P. F. MOTTELAY.

ANA (J. F.), M. D., Chemical Assistant in Harvard University and Lecturer on Chemistry and Pharmacy in Dartmouth College, writes, Jan. 25, 1819, to Prof. Benjamin Silliman concerning his new form of portable electrical battery.

This apparatus, consisting of alternate plates of flat glass and of tin-foil, the alternate sheets of which latter are connected together, is fully described at pp. 292-294, and is illustrated opposite p. 233, vol. i. of Silliman's *American Journal of Science*, 1818, wherein it is stated that, while "in a battery of common form, 2 feet long, 1 foot wide and 10 inches high, containing 18 coated jars, there will be no more than 3,500 square inches of coated surface," a battery of Dana's construction will have no less than 8,000 square inches covered with tin-foil, allowing the sheet of glass and of foil to be ¼-inch thick. In a brief description of this apparatus which appears at p. 463, vol. iv., of Tilloch's *Phil. Mag. and Journal*, it is stated that a "battery constructed in this way contains, in the bulk of a quarto volume, a very powerful instrument; and when made of glass, it is extremely easy, by varnishing the edges, to keep the whole of the inner surfaces from the air, and to retain it in a constant state of dry insulation."

A. D. 1820.——On Oct. 9 Mr. Boisgeraud, Jr., reads, before the French Académie des Sciences, a paper concerning many experiments he has carried on but which prove to be merely variations of those previously made by Oersted.

He observed that connecting wires, or arcs, placed anywhere in the battery would affect the needle, and he noticed the difference of intensity in the effects produced when electrical conductors were employed to complete the circuit. He proposed, however, to ascertain the conducting power of different substances by placing them in one of the arcs, cells or divisions of the battery, and bringing the magnetic needle, or Ampère's galvanometer, toward another arc, viz., to the wire, or other connecting body used to complete the circuit in the battery. With regard to the positions of the needle and wire, as observed by Mr. Boisgeraud they are all confirmatory of Prof. Oersted's statement.[1]

One month later, Nov. 9, 1820, Mr. Boisgeraud reads before the same academy his paper "On the Action of the Voltaic Pile upon the Magnetic Needle," which will be found on pages 203-206 and 257, 258, vol. lvii., of the *Philosophical Magazine*.

A. D. 1820.——Banks (Sir Joseph), a very eminent English naturalist and traveler, to whom reference has been made under the A. D. 1775 date, deserves mention here were it alone for the fact that while occupying the presidential chair of the Roy. Soc., during the extraordinarily long and unequaled period of over *forty-two years* (1777, date of Sir John Pringle's retirement, to 1820, the date of President Banks' death) he was instrumental in bringing prominently before the world many of the most important discoveries and experiments known in the annals of magnetism and electricity.

Sir. Joseph Banks was succeeded in the presidency of the Royal Society by William Hyde Wollaston, M. D., June 29, 1820, and by Sir Humphry Davy, Bart., Nov. 30, 1820, the last named holding the office seven years.[2] He and Dr. Solander, the pupil of Linnæus, had sailed (1768-1771) with Captain Cook in his voyage around the globe, in the capacity of naturalists, and afterwards (1772) visited Iceland, where they made many important discoveries. In 1781 Banks was created a baronet; he received the Order of the Bath in 1795 and subsequently had many honors conferred upon him by different English and foreign societies. It is said that he was never known to be appealed to in vain by men of science, either for pecuniary assistance or for the use of his extensive library.[3]

A. D. 1820.——Barlow (Peter), F. R. S., who taught mathematics at the Military Academy of Woolwich from 1806 to 1847, brings out his first edition of his "Essay on Magnetic Atractions, Particularly as Respects the Deviation of the Compass on Shipboard Occasioned by the Local Influence of the Guns, etc., with an Easy Practical Method of Observing the Same in all Parts of the World." One of his biographers states that through this valuable publication, which received the Parliamentary reward from the then existing Board of Longitude as well as presents from the Russian Emperor, he was the first to reduce to strictly mathematical principles the method of compensating compass errors in vessels.[4]

This work contains the results of the many experiments to ascertain the influence of spherical and other masses of iron upon the needle which he instituted, more particularly after Prof. Hansteen's investigations became generally known. Sir David Brewster details Barlow's work in the "Encycl. Britan.," and refers to the observations of Mr. Wm. Wales (at A. D. 1774), Mr. Downie (at A. D. 1790), Captain Flinders (at A. D. 1801), and Charles Bonnycastle (at A. D. 1820), adding that it is to Mr. W. Bain we owe the distinct establishment and explanation of the source of error in the compass arising from the attraction of all the iron on board of ships. The small 140-page book which Mr. Bain published on the subject in 1817 is entitled "An Essay on the Variation of the Compass, Showing how Far It Is Influenced by a Change in the Direction of the Ship's Head, with an Exposition of the Dangers Arising to Navigators from not Allowing for This Change of Variation." Brewster remarks that additional light was thrown upon Mr. Bain's observations by Captains Rows, Parry and Sabine, but that it is to Prof. Barlow alone that we owe a series of brilliant experiments which terminated in his invention of the neutralizing plate, for correcting in a perfect manner this source of error in the compass.[5] The simple contrivance therein alluded to is described and illustrated at pp. 9 and 90, 91, of the "Britannica," article on "Navigation," and may briefly be said to consist of only a thin circular plate of iron placed in a vertical position immediately behind the binnacle or compass.[6] Such plates were immediately tried in all parts of the world and were at once applied to the vessels Conway, Leven and Barracouta.[7]

For Mr. Barlow's experiments on the influence of rotation upon magnetic and non-magnetic bodies, the result of which was communicated by him to the Royal Society, April 14, 1825, six days before the receipt of Mr. K S. H. Christie's paper "On the Magnetism of Iron, Arising from Its Rotation," communicated by Mr. J. F. W. Herschel, see pages 10, 33, 34 of the "Britannica, vol. xiv., above referred to."[8]

The new variation chart which Prof. Barlow constructed and in which he embodied the magnetic observations made in 1832 by Sir James Ross, R. N., is described and illustrated in *Phil. Trans.* for 1833, pages 667-675, plates xvii., xviii. He remarks that the very spot where his officer found the needle perpendicular, "that is, the pole itself, is precisely that point in my globe and chart in which, by supposing all the lines to meet, the several curves would best preserve their unity of character, both separately and conjointly as a system."[9]

Mr. Barlow's electro-magnetic globe was exhibited by Dr. Birbeck in his lectures on Electro-Magnetism at the London Institution, May 26, 1824.[10] Its purpose was to show that what had hitherto been considered as the magnetism of the earth might be only modified electricity, and it was also intended to illustrate experimentally the theory advanced by Mr. Ampère, who attributed all magnetic phenomena to electric currents. In the words of Dr. Brewster:

> Barlow considers it as probable that magnetism as a distinct quality has no existence in nature. As all the phenomena of terrestrial magnetism can be explained on the supposition that the magnetic power resides on its surface, it occured to Mr. Barlow that if he could distribute over the surface of an artificial globe a series of galvanic currents, in such a way that their tangential power should everywhere give a corresponding direction to the needle, this globe would exhibit, while under electrical induction, all the magnetic phenomena of the earth upon a needle freely suspended above it. Mr. Barlow says, "he has proved the existence of a force competent to produce all the phenomena without the aid of any body usually called magnetic," yet he acknowledges that "we have no idea how such a system of currents can have existence on the earth, because, to produce them, we have been obliged to employ a particular arrangement of metals, acids, and conductors.

He was the first to test the practicability of Ampère's suggestion that by sending the galvanic current through long wires connecting two distant stations, the deflections of inclosed magnetic needles would constitute very simple and efficient signals for an instantaneous telegraph.[11] He has thus stated the result: "In a very early stage of electro-magnetic experiments, it had been suggested (by Laplace, Ampère and others) that an instantaneous telegraph might be established by means of conducting wires and compasses. The details of this contrivance are so obvious, and the principle on which it is founded so well understood, that there was only one question which could render the result doubtful; and this was, is there any diminution of effect by lengthening the conducting wires? It had been said that the electric fluid from a common (tin-foil) electric battery had been transmitted through a wire four miles in length without any sensible diminution of effect, and, to every appearance, instantaneously; and if this should be found to be the case with the galvanic circuit, then no question could be entertained of the practicability and utility of the suggestion above adverted to. I was therefore induced to make the trial; but I found such a sensible diminution with only 200 feet of wire, as at once to convince me of the impracticability of the scheme. It led me, however, to an inquiry as to the cause of the diminution, and the laws by which it is governed. This passage is quoted in "Smithsonian Report" for 1878, p. 279: "Fahie," "Hist. El. Tel.," p. 306; "Memor. of Jos. Henry," 1880, pp. 223,224, the last named containing the following foot note: "On the Laws of Electro-Magnetic Action," *Edinburgh Philosophical Journal*, Jan., 1825, vol. xii., pp. 105-113.

> In explanation and justification of this discouraging judgment from so high an authority in magnetics, it must be remembered that both in the galvanometer and in the electro-magnet, the coil best calculated to produce large effects was that of least resistance; which unfortunately was not that best adapted to a long circuit. On the other hand the most efficient magnet or galvanometer was not found to be improved in result by increasing the number of galvanic elements. Barlow in his inquiry as to the law of diminution was led (erroneously) to regard the resistance of the conducting wire as increasing in the ratio of *the square* root of its length. (Pages 110, 111 of the last cited "Journal.")

Mr. Taylor justly adds that subsequent experiments have proved Ohm's law (announced three years after Barlow's) of a simple ratio of resistance to length as approximately correct.[12]

A. D. 1820.——Laplace (Pierre Simon, Marquis de), a very distinguished French astronomer and mathematician, suggests the employment for telegraphic purposes of magnetic needles suspended in multipliers of wire, in place of the voltameters of Sömmering, and on the 2d of October, 1820, his theory is thus explained by Ampère in a paper read before the French Academy of Sciences.

> According to the success of the experiment to which Laplace drew my attention, one could, by means of as many pairs of live wires and magnetic needles as there are letters of the alphabet, and by placing each letter on a separate needle, establish, by the aid of a distant pile, and which could be made to communicate by its two extremities with those of each pair of conductors, a sort of telegraph, which would be capable of indicating all the details that one would wish to transmit through any number of obstacles to a distant observer. By adapting to the battery a keyboard whose keys were each marked with the same letters and establishing connection (with the various wires) by their depression, this means of correspondence could be established with great facility, and would only occupy the time necessary for pressing down the keys at the one station and to read off the letters from the deflected needles at the other.

As will be seen later on, this idea of Laplace, which was partly developed by Ampère, was still further advanced during 1830 by Ritchie, Professor of Natural Philosophy in the Royal Institution.

Laplace is, perhaps, best known by his "Traité de Mécanique Céleste," the sixteen books and supplements to which are said to be next to Newton's "Principia," the greatest of astronomical works, a work which has been truly said to have had no predecessor and which has been called the crowning glory of Laplace's scientific career. His next important work was the "Théorie Analytique des Probabilités," the most mathematically profound treatise on the subject which has yet appeared, while his "Système du Monde" was called by Arago "one of the most perfect monuments of the French language." By Prof. Nichol Laplace is called "the titanic geometer;" by Mr. Airy "the greatest mathematician of the past age;" by Prof. Forbes "a sort of exemplar or type of the highest class of mathematical natural philosophers of this, or rather the immediately preceding age."

Laplace also wrote, in conjunction with Lavoisier, a treatise "On the Electricity Which Bodies Absorb When Reduced to Vapor."[13] Prof. Denison Olmstead, treating of the origin of atmospherical electricity[14] says: "Among the known sources of this agent none seems so probable as the evaporation and condensation of watery vapor. We have the authority of two of the most able and accurate philosophers, Lavoisier and Laplace, for stating that bodies in passing from the solid or liquid state to that of vapor, and, conversely, in returning from the aeriform condition to the liquid or solid state, give unequivocal signs of either positive or negative electricity," and he adds, in a foot note:

> Mr. Pouillet has lately published a set of experiments, which seems to overturn Volta's theory of the evolution of electricity by evaporation. He has shown that no electricity is evolved by evaporation unless some chemical combination takes place at the same time. . . ." (Thomson, "Outlines," p. 440). . . But we shall be slow to reject the results of experiments performed by such experimenters as Lavoisier and Laplace, especially when confirmed by the testimony of Volta and Saussure.

With regard to the origin of meteorites, Laplace has advanced his very bold theory that they may be products of Luna, volcanoes, and Prof. Lockhart Muirhead states that he will "present the reasoning upon which this extraordinary hypothesis is founded in the popular and perspicuous language of Dr. Hutton, of Woolwich. The respect due to the name of Laplace will justify the length of the extract," which he gives at pages 633-635, vol. xiv., of the 1857 "Britannica."[15]

Mr. Cyrille Pierre Théodore Laplace, captain in the French navy, is the author of the "Voyage Autour du Monde. . . . sur la Corvette Favorite. . . ." and of "Campagne de Circumnavigation de la Frégate *l'Artémèse*. . . ." published in Paris during the years 1833, 1839 and 1841.

(To be continued.)

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[1] "Ency. Met." (Electro. Mag.) vol. iv., p. 6.
[2] R. Weld, "His. Roy. Soc.," 1848, vol. ii., p. 359.
[3] See Tilloch's *Phil. Mag.* for 1820, vol. lvi., pp. 40-46; "Cat. Sci. Papers Roy. Soc.," vol. i., p. 178; Dr. Thomas Thomson, "Hist. Roy. Soc.," London, 1812, p. 12; *Gentleman's Magazine* for 1771, 1772 and 1820; "Biog. Univ.," vol. lvii., Suppl., p 101; Larousse, "Dict. Univ.," vol. ii., p. 155; "Eloge Historique de Mr. J. Banks, lu à la Séance de l'Académie Royale des Sciences, le 2 Avril, 1821;" Sir Everard Home, "Hunterian Oration," Feb. 14, 1822. See besides, the *Phil. Mag.*, vol. lvi., pp. 161-174, 241-257, for "A review of some of the leading points in the official character and proceedings of the late President of the Royal Society."
[4] *Edinb. Jour. of Sci.*, London, 1826, vols. i. pp. 181, 182; ii., p. 379.
[5] Noad's "Manual," pp. 531, 532; Olmstead's "Introduct. to Nat. Hist.," 1835, pp. 206 210.
[6] Fifth Dissertation of "Britannica," vol. i., p. 745, and article "Seamanship," in vol. xx., p. 27.
[7] *Trans. Soc. of Arts*, for 1821, vol. xxxix., pp. 76-100; Harris' "Rud. Mag.," iii., 69-76; John Farrar, "Elem. of El. . . . ." 1826, pp. 376-383; *Westminster Review*, for April, 1825; "Encycl. Metropol." vol. iii. (Magnetism), pp. 743, 799.
[8] See also *Edinb. Jour. of Science*, 1826, vols. iii., p. 372, and v., p. 214. Consult, also, J. Farrar, "Elem. of El.," 1826, pp. 387-395, while, for his extensive observations regarding the influence of heat on magnetism and relative to the variation, as well as for the mode of constructing his artificial magnets, consult the same volume of the "Britannica," at pages 35, 36, 50-53 *et seq.*, and p. 73. See, likewise, for the variation, Dr. Thomas Thomson's "Outline of the Sciences," London, 1830, pages 549-556; Harris, "Rud. Mag.," i., ii., pp. 152-153.
[9] Eighth "Britan," vol. xiv., note p. 59; Noad, "Manual," p. 617; D. Olmstead, "Intr. to Nat. Phil.," 1835, p. 192.
[10] Its construction is fully described, more particularly, at page 65 of the English "Encycl. Britan." (Magnetism), p. 91 of the "Lib. of Useful Knowledge" (Electro-Magnetism), pp. 139-140, vol. i. of the *Edinb. Jour. of Science*, London, 1826, and pp. 120-122, part iii., of Harris' "Rud. Mag."
[11] *Ann. de Chimie et de Phys.*, 1820, vol. xv., pp. 72, 73.
[12] G. B. Prescott, "The Speaking Telephone," 1879, ii.; *Sci. Am. Supp.*, Nos. 405, p. 6,466, 433, p. 7,235, 547, p. 8,735; "Mem. of Jos. Henry," 1880, pp. 83, 94, 144, 485, 487.) See, also, Poggendorff, vol. i., pp. 102, 103; Whewell "Hist. Ind. Sciences," 1859, vol. ii., pp. 223, 224, 245, 254, 616; "Lib. Useful Knowledge" (Magnetism), p. 68, and (El. Mag.), pp. 7, 18, 22, 28; "Abstracts of the Papers . . . of the *Phil. Trans.* 1800-1830," vol. ii., pp. 164, 241; Sturgeon's "Sci. Researches," Bury, 1850, pp. 26, 29, 31, 298; Humboldt, "Cosmos," 1849, vol. i., p. 183; Mrs. Somerville, "On the Earth not a Real Magnet," in the "Conn. of the Phys. Sci."; *Phil. Mag.*, vols. lv., p. 446, lx., pp. 241, 343, lxii., p. 321; Harris, "Rud. Mag.," part iii., pp. 114-116; "Encycl. Metropol.," vol. iv. (Elect. Mag.), pp. 1-40.
[13] *Mém. de Paris*, for 1781.
[14] "Introd. to Nat. Phil," 1835, pp. 158, 159.
[15] Humboldt, "Cosmos," London, 1849, vol. i., pp. 108, 109; Young, "Course of Lectures," London, 1807, vol. ii., p. 501, alluding to "Zach. Mon. Corr.," vi., 276, also to Gilbert, xiii., 353, and stating that Olbers had suggested Laplace's idea in 1795. See "Mem. of the Astronom. Soc. of London," vol. iii., p. 395; Laplace, "Mém. de l'Institut," for 1809, p. 332; Dr. Young's "Course of Lectures," 1807, vol. i., pp. 249, 250, 522, vol. ii., p. 466; Humboldt, "Cosmos," London, 1849, vol. i., pp. 28, 76, 130, vol. ii., page 712; Lavoisier at A. D. 1781: Biot at A.D. 1803; *Annal. de Ch. et Phys.*, vol. xv., pp. 72, 73, and, for Laplace and Lavoisier, see Delaunay, "Manuel . . . ." 1809, p. 178; "Mem. de l'Acad. des Sc.," for 1781.

The Silvey System of Electric Lighting for Railway Trains.

The lighting of railway trains is a task of no mean importance, inasmuch as upon a proper performance of this work, the comforts of the traveling public largely depend. Poorly lighted and poorly heated cars are matters of more complaint from the traveling public than perhaps any other ill convenience inherent to railroads. The lighting of trains has become one of the brightest themes of the railway advertiser. Almost every road in operation which caters to the wants of through travel, will be found to advocate some modern system of lighting.

The oil lamp and the car stove are the abomination of the traveling public, and well they may be, for how often have we seen their awful work. Often and often it is that a wrecked train is converted into a charnel house by these deadly incendiaries. Incendiaries they may well be called, when it is considered that in the neighborhood of two hundred thousand car lamps are burned every night, and about fifty thousand car stoves stand a

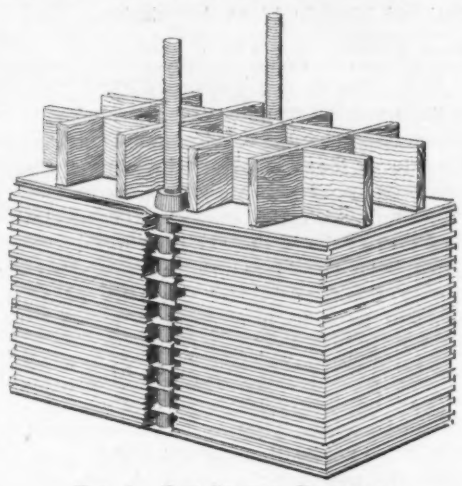


FIG. 1.—THE SILVEY BATTERY.

menace to the lives of passengers and the valuable property of the railroad company.

The air brake, once a luxury and advertising medium, has lost its novelty, and is now a necessity, so much so in fact, that it would be considered almost an absolute impossibility to run trains without its friendly aid. The days of the tallow dip and kerosene lamp are numbered, and while the gas lamp is still in use on many cars, the great liability and high explosive character of the high pressure tanks in which the hydrocarbon vapor is stored, the liability of leakage, together with the complex operative devices required in its consumption must soon seal the doom of the gas lamp.

If the general public was only aware of the facts, that in each tank under the car there is stored a gasoline vapor under a pressure of not less than 150 pounds per square inch, and that in this apparently harmless cylinder there is enough energy, which if ignited by any accident, will blow a train of cars to atoms, state legislation would be invoked to peremptorily abolish this most potent danger.

An allusion to only three accidents where this messenger of death has done his work, is enough to call the attention of the people to a painful realization of undesirable facts. A gas tank exploded on a passenger car near Nantes, France, wrecking the train, and without a moment's warning launching 200 passengers into eternity. But coming nearer home, within the present year a number of accidents can be recited, caused by the explosion of gas on cars, among which the explosion of the gas on the Chicago & Erie Railroad near Lima, where the pipes sprung a leak, the gas became ignited from the conductor's lantern, wrecking the car and consuming the wreck before the fire could be extinguished. These messengers of death, coming in quick succession, warn us that the days of gas lighted cars are nearly numbered. Already state legislation has, in many cases, banished the car stove, compelling the railroads to use steam heated cars, and in some instances the oil lamp has been legislated out of existence. With all these dangers lurking in our midst, it is no wonder that railroad managers have turned a wistful eye to electricity, the safest, cleanest, brightest and most perfect illuminator.

The lighting of passenger cars by electricity was attempted nearly as early as the lighting of dwellings and business houses, but the task of lighting railway cars has been a problem vastly more difficult to handle, as the conditions met were of such a complex nature as to render the task one of the most severe which the electrical engineer could encounter.

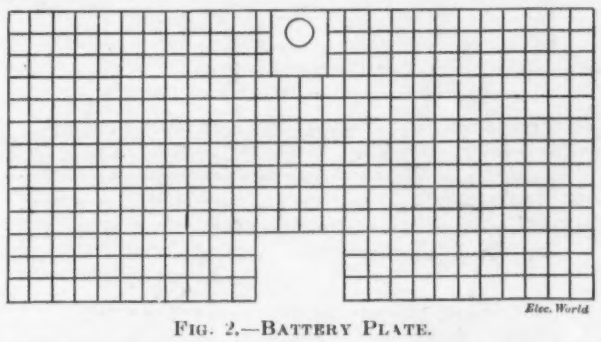
Up to the present time thirty-three patents for electric lighting have been issued in the United States, the first patent bearing date of Dec. 13, 1881. All of these systems depended more or less on a dynamo machine located on the train, and most of them having a set of storage batteries as a reserve, in case the dynamo should fail, showing full well the inventor did not have confidence enough in his invention to confine himself to the secondary battery alone, and by this lack of confidence, he must need be resort to all manner of accessory circuits and devices, enough in fact, to complicate and ruin any system. An examination of the patents reveals the fact that in nineteen cases the dynamo was dependent on the motions of the car for its electric energy, and they will be found located in almost every conceivable position, from the pilot of the locomotive to the rear platform of the train. In the other cases an independent engine is employed, in every instance located in the baggage car save one, where it is found that the engine and dynamo are located on the pilot of the locomotive. A central source of power seems to have been the idea of all these patents without a single exception, the cars being coupled together by flexible connections and dependent entirely on the train dynamo for generation of current, so that in case of a breakdown of the dynamo, the cars would soon be in darkness, unless provided with the dangerous auxiliary oil lamp. This manner of operating the electric light has proved to be too expensive and complicated to permit its general adoption, but it has been worked so assiduously that the management of railroads have almost come to the conclusion that the electric lighted train is a will-o'-the-wisp and not to be depended upon, something beautiful and perfectly safe from fire, but not safe to tie to, and therefore the introduction of a thoroughly reliable system of electric light has been found to require the very hardest kind of work, owing to the butchery to which electric light has already been subjected.

The Silvey system of electric lighting for passenger cars was first brought out in the spring of 18[illegible], and tested on the C., H. & D. R. R. At the end of a two months' test, a train of cars was equipped with the system on the C., C., C. & St. L. R. R., running between Dayton, Ohio, and Cincinnati, and operated continuously for about eight months, the batteries being charged once a week at the works of the Dayton Manufacturing Co., and hauled to the train about two miles away. The batteries having proved themselves perfectly reliable and able to make long runs, arrangements were entered into for equipping passenger trains on the A., T. & S. F. and the C. & O. R. R., their plants having now been in daily use for more than eleven months without a slip of any kind. The Chesapeake & Ohio Railroad have all the batteries for fifty-four cars, a good part of them being in daily use, a number of cars being now under construction which will largely increase this number. Their charging station, located at Covington, Ky., a suburb of Cincinnati, is a model of convenience and engineering skill, every means known being provided for handling the batteries quickly and easily, two men being sufficient to take care of the batteries for 30 cars, which cuts the running expenses considerably below that of oil lights for the same quality and quantity of light. The charging station is arranged to charge enough batteries for thirty-two cars constantly, the charging of a set of batteries to run from Cincinnati to New York, Washington or Old Point Comfort, Richmond, and return, requiring about ten hours, and, therefore, the station of the C. & O. R. R. is capable of charging enough batteries for sixty-four cars every twenty-four hours.

The cars are lighted with eight 16 c. p. lamps in the body of the car, and a vestibule lamp on each platform, making ten lights in all, the batteries being located in battery removable trays, which are slid into permanent boxes underneath the car.

The aim of the constructors of this battery has not been to push the efficiency of the apparatus to the utmost limit, making it very light in weight, but rather to make an apparatus capable of withstanding almost any amount of hard usage, and at the same time a battery that could be depended upon whenever needed, and one which if handled with any degree of care at all would always do its duty. It is believed that all this has been fully accomplished, inasmuch as although the battery has been doing constant lighting service on railroads for the last two and a half years, no such thing as a short circuit or buckled plate in the cells has ever occurred from any cause. Cells having a rated capacity of 30 amperes discharge have frequently been entirely discharged at the rate of 120 amperes, and charged at the rate of 100 amperes without doing any harm, either in losing the active oxide or buckling the plates. While these extreme charges and discharges do not occur in service, it was thought best to be sure that they would stand at least four times as great a strain as would ever occur in practice.

The vital part of the system is the battery, as upon its proper performance the economy of the system depends. Low internal resistance must be assured before it is possible to operate without regulating devices, which in



Elec. World

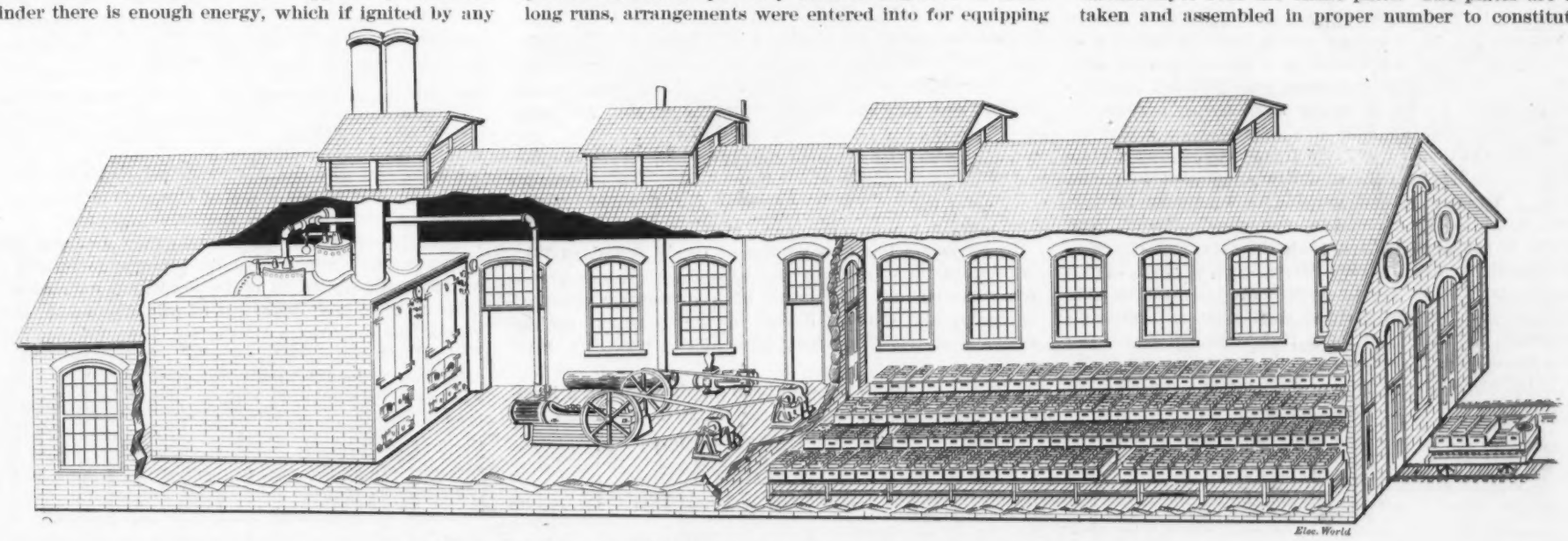
FIG. 2.—BATTERY PLATE.

all cases are absorbents of energy, and in a sense more or less responsible for lack of economy.

Fig. 1 shows the battery, the hard rubber cell in which it is placed being broken away in order to show its construction. The battery plates proper are shown in Fig. 2, to consist of a metal grating six by twelve inches square, and about one-eighth of an inch thick, twenty-one of which constitute a complete battery cell. These lead plate castings are taken and laid on their side, in a bath and by an electrical process which is entirely original with the Silvey System, they are filled with electrolytically deposited spongy lead, after which they are placed in a bath which hardens the spongy lead into a firm coherent mass, almost as hard as a rock, and by which it becomes firmly fixed into the holes and forms a surface layer over the entire plate. The plates are now taken and assembled in proper number to constitute a complete battery, there being one more negative than positive plate, as for instance, eleven negative and ten positive battery plates. The plates are clamped together by means of a lead screw passing through the hole in the plate as shown in Fig. 1, a nut being placed between each plate and firmly screwed down, whereby good metallic contact is made and all soldering avoided. In case it ever becomes desirable to take the cell apart, it is easily done by removing these nuts.

This battery is a radical departure from anything ever before attempted, and is covered by a number of broad patents issued to W. L. Silvey, and also a number of other applications for patents which are still pending. The filling for the battery plates being chemically pure lead, which has been found in practice to give a useful working output of about 22 per cent. greater efficiency than is possible with batteries employing a mechanically filled plate of lead oxide, which necessarily contains large quantities of impurities.

Between each set of plates in the Silvey battery there is placed sheets of a porous separating material, which



Elec. World

FIG. 3.—TRAIN LIGHTING BY STORAGE BATTERY: POWER PLANT.

has been treated with acids and alkalis until they become practically indestructible in the electrolyte, and which are capable of absorbing more than four times their own weight of the acids used in the battery, which, in fact, becomes nearly a dry cell, or in other words, there is very little free liquid to become spilled, and should the rubber cell ever become broken, the liquid held in suspension in the bibulous separating material is sufficient to operate the lights properly during a trip. In order to prevent any possible splash of the free liquid on top of the battery plates, the cell is made very deep, the plates only filling the jar about half its depth, and as an additional precaution, a sort of wooden crate, shown in Fig. 1, is laid on top of the plates, dividing the interior of the cell into small pockets, preventing the formation of waves incident to a car in rapid motion over an uneven track.

The charging station of the C. & O. R. R. Co.'s plant is shown in perspective in Fig. 3. The station for charging the battery is something unique in details, and on a scale never before attempted. The station proper is divided into two principal parts by a partition, one of which contains two 100 horse power boilers, and an automatic engine of the very latest design, together with Silvey dynamo, capable of giving an output of 700 amperes each. The switchboard is equipped with all the latest improvements in the way of ampere meters and volt meters, together with rheostats for regulating the voltage of the dynamos, which are shunt wound and coupled in

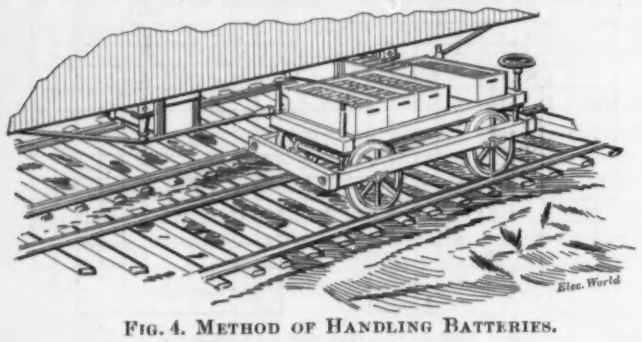


Fig. 4. Method of Handling Batteries.

multiple to copper bars, leading to the charging racks, these copper bars ½ inch by 1½ inches square, capable of carrying an output of nearly double that of the dynamos. The main line circuit is arranged on the return circuit or equalizing principle, so that no matter how closely or remote the batteries are situated, every cell gets exactly the same voltage. To do this, main line copper bars are run, to which all the cells are connected. The necessity of this equalization becomes apparent when it is considered that an increase of only two volts on a set of cells, will nearly double the amount of current consumed, which necessitates a nicety of regulation in the distributing mains never before employed in electrical engineering; at the same time every part of the apparatus is extremely substantial, and of a most simple character. The station has a capacity for charging 1,536 cells of battery every twenty-four hours, each cell having a floor space 7 by 13 inches, and a working capacity of 350 ampere hours. Of course in a labratory test, they will do much better as to storage capacity, but this output is found to be practical in everyday service on trains. The battery cells are arranged in trays, six being placed in each tray, two trays constituting a complete set or twelve cells of battery, coupled in series, giving a working output capable of operating 25 volt lamps in the cars up to their full candle power. The station is provided with a properly arranged charging table, as showed in the plan views, each division of the table having rollers, which enables the operator to slide the battery trays into position with very little effort.

Between the racks are small tramways, on which the tram car, Fig. 4, travels, so that in supplying the trains with batteries the trays are pulled from the charging racks onto the car, and carried thence to the train and put into the car boxes. A good idea of the operation of changing batteries may be obtained from the figure. This transfer car is operated on a track having a 2 foot 6 inch gauge, each corner being provided with a vertical screw, on which a sprocket wheel is fastened, on which an endless link belt is carried entirely around the car, so that the frame may be lowered or raised from either corner by turning the hand wheel and raising or lowering the frames to conform to the irregular heights of passenger car. The car boxes as well as the battery trucks are provided with 2½-inch rollers, on which the battery trays rest, making the changing of the batteries a task very easily accomplished in the shortest possible time, it being found perfectly practicable for two men to change all the batteries under an entire train of average length in less than 15 minutes.

In operating the light in the cars, a switch of the snap variety is provided, having a cover and a key of a peculiar pattern for turning the lights on or off, thereby preventing all meddling with the circuit by any but the proper persons. Each lamp in addition is provided with a key socket and a fusible cut-out, making it impossible for any lamp to disarrange the operation of the others, and by the peculiar equalizing patented principle of wiring employed only with the Silvey system, every lamp burns exactly alike, together with the placing of the lamps beneath the deck sill of the car, and by staggering them, every part of the car is lighted to a uniform brilliancy. The cars are all independent of each other, each car being provided with its own batteries, rendering the system as flexible as anything imaginable; in fact, cars are often away from the changing station at Covington for as long as two weeks, the trains being broken up at Gordonsville, one part going to Richmond and Old Point Comfort, Va., the remainder to Washington or New York. It has been found in practice that the batteries will light the cars for three nights at one changing, and are therefore able to light a train in a first-class manner through a journey of about 2,000 miles.

When it is considered that in this system the train dynamo has been entirely discarded, together with all rheostats and regulating devices of every description, and that every car is entirely independent of all the rest, it will be seen a great stride has been made, which will ultimately wipe out the oil light almost entirely if not displace gas as an illuminator.

The following tables are a correct comparison of the three systems, oil, gas, and electricity, for lighting railway cars.

This system of lighting, the invention of W. L. Silvey, is manufactured and put on the market by the Dayton Manufacturing Company, of Dayton, O.

NEW BOOKS.

Tips to Inventors. By Robert Grimshaw. 84 pp. New York: Practical Publishing Company, 1892. Price $1.

In this little book the author, whose practical ideas on a great variety of mechanical and electrical subjects is well known, has covered this subject in thirteen chapters, giving "tips" to electrical inventors the preference, by making this the subject of his first chapter. Other chapters on heating and lighting, power, railway lines, etc., are fully as interesting from a practical point of view.

Standard Tables for Electric Wiremen, with Instructions for Wiremen and Linemen, Etc. By Charles M. Davis. Third edition. Thoroughly revised and edited by W. D. Weaver. 100 pages. Illustrated. New York: The W. J. Johnston Co., Ltd. Price $1.00.

In preparing this new edition of Davis' Standard Wiring Tables, the object has been to produce a working book for wiremen and electricians of a thoroughly practical character and entirely devoid of the padding, useless tables and verbiage that generally accompany such works.

The wiring tables have all been recalculated on a basis of 55 watt lamps, and it is believed that this is the first uniform set of tables published.

A valuable table here appears for the first time by means of which the tables of the three standard voltages can be used for any other voltage and also for other drops than those in the tables.

The method of determining the sizes of conductors has been proved in practice, and the wiring formulae for motor circuits, etc., are put in their simplest and most practical form.

The formulae for horse power of engines and boilers are published for the first time, and, while they are based on rational principles, the different value of heating surface in boilers being considered, the results they give are the actual commercial ratings and not the theoretical powers.

The tables of the limiting currents for exterior wiring and the candle power of arc lamps are published for the first time in their present form.

Mr. James I. Ayer's valuable instructions for linemen (revised), are included with permission of the author, and also the excellent Rules for Save Wiring adopted by the National Electric Light Association.

Original Papers on Dynamo Machinery and Allied Subjects. By Dr. John Hopkinson. 249 pages, 98 ills. New York: The W. J. Johnston Co., Ltd. Price $1.00.

This little volume contains the collected papers of Dr. Hopkinson upon electro-technical subjects that have been published in various journals and society transactions in the last 13 years. These are republished exactly as they first appeared, with the exception of whatever errors were known to exist in their original form. These papers have long been considered the authoritative statement of many of the fundamental principles of dynamo machinery, and have been referred to as such in almost every book or paper on this subject by other authors, whether English or American; for this reason their publication in this convenient form for ready reference will be appreciated by electro-technical students, as many of the publications in which they have originally appeared are now very scarce and difficult to obtain. The collection includes, of course, Dr. Hopkinson's memorable paper on dynamo-electric machinery, presented to the Royal Society in 1886, together with the supplementary paper read before the same society during the present year. Besides these two papers the collection includes Dr. Hopkinson's three papers on electric lighting, his paper on the theory of alternating currents, the report made to the Westinghouse company on transformer tests in May of this year, a paper on the theory of the alternate current dynamo, his paper describing the electric lighthouses of Macquarie and Tino, besides two brief papers on induction coils, and on an unnoticed danger in certain apparatus for distribution of electricity. These 11 papers comprise all that Dr. Hopkinson has written on these subjects and are for the first time published in a collected form, and thus rendered more accessible to the general public. The majority of the papers contain no mathematical formulae, while those on alternating current work, which are to a certain extent necessarily mathematical, will be readily understood by those who care to pursue this line of study.

Electricity and Magnetism: Being a Series of Advanced Primers. By Edwin J. Houston. 306 pages, 116 illustrations. New York: The W. J. Johnston Co., Ltd., 189'. Price $1.00.

During the Philadelphia Electrical Exhibition of 1884 Prof. Houston issued a set of electrical primers for the benefit of the visitors to the exhibition, and the great popularity and wide general sale they attained showed that the public appreciated the attempt to furnish them a literature they could easily read and understand. As these primers have been out of print for some time the author has prepared a new series, but on somewhat different lines.

During the last eight years the advances in the applications of electricity have been so great and so widespread that the public would no longer be satisfied with instruction in regard to only the most obvious and simple points, and accordingly the new primers are of a more advanced character as regards matter and extent; the treatment, however, remains such that they can be easily understood by any one without a previous knowledge of electricity.

This volume contains eighteen primers in all, the last one being a review, or "Primer of Primers," which sums up the salient features of the different topics treated. The subjects of the different primers relate to the various sources and phenomena of static and current electricity, and of magnetism, with practical deductions and applications. Atmospheric electricity and the phenomena of the earth's magnetism receive a particularly interesting treatment, and the primers on the electromagnet, electro-receptive devices, and frictional and influence machines are very practical in their scope.

A feature of the work is the abstracts from standard electrical authors at the end of each primer, which generally have reference, and furnish an extension, to some important point in the primer, and at the same time give the reader an introduction to electrical literature.

While the work is primarily intended for popular reading, the care of statement and logical development of principles make it a valuable work for electricians who wish to gain a knowledge of, or to review, the principles upon which the science is based.

COST TO EQUIP AND MAINTAIN 50 CARS WITH SILVEY'S STORAGE BATTERY SYSTEM.

144 candle power to each car, 15 hours per day, 365 days, 5,475 hours.

	12 cells single equipment with one charging plant.	12 cells single equipment with two charging plants.	24 cells double equipment with one charging plant.
Charging plant	$4,324.00	$8,648.00	$4,324.00
Equipment	15,787.00	15,787.00	30,117.00
Total amount invested for 50 cars	20,111.00	24,435.00	34,441.00
Amount invested for one car, including charging plant	402.22	488.70	688.82
COST OF MAINTENANCE.			
Interest on investment at 6 per cent	$1,205.66	$1,466.10	$2,066.46
Depreciation on charging plant at 10 per cent	432.40	864.80	432.40
Depreciation on equipment at 15 per cent	2,367.00	2,367.00	4,517.55
Engineers at $720 per year	720.00	1,440.00	720.00
Laborers at $480 per year	960.00	1,920.00	960.00
Coal at $300 per year	300.00	600.00	300.00
Oil, waste, etc., at $60 per year	60.00	120.00	60.00
Total cost for 50 cars for one year	$6,045.00	$8,777.90	$9,056.41
Total cost for one car for one year	120.90	175.56	181.13
COMPARISONS.			
Storage battery. Total hourly cost for one car	Weight 950 lbs., 2½ cents.	Weight 950 lbs., 3¼ cents.	Weight 1,857 lbs., 3⅛ cents.
Pintsch gas. Total hourly cost for one car	Weight 1,300 lbs., 6$\frac{33}{100}$, 7⅛ cents.	Weight 1,300 lbs., 6$\frac{33}{100}$ cents.	Weight 1,900 lbs., 6$\frac{37}{100}$ cents.
Oil lamps with Acme burners. Total hourly cost for one car	Weight 180 lbs., 4$\frac{37}{100}$ cents.	Weight 180 lbs., 4$\frac{37}{100}$ cents.	Weight 180 lbs., 4$\frac{37}{100}$ cents.
Oil lamps with dual or machine burners. Total hourly cost for one car	Weight 210 lbs., 3$\frac{7}{10}$ cents.	Weight 210 lbs., 3$\frac{7}{10}$ cents.	Weight 210 lbs., 3$\frac{7}{10}$ cents.

Advertising in the Clouds: Its Practicability.

In a recent issue of THE ELECTRICAL WORLD comments were given on the proposition to utilize the clouds for advertising purposes. One of our daily contemporaries has taken the matter up and has obtained among others the following opinions from Mr. E. H. Johnson, Dr. S. S. Wheeler and Prof. F. B. Crocker regarding the practicability of the scheme:

"The thing is entirely feasible," said E. H. Johnson, president of the Interior Conduit and Insulation Company, "by virtue of the fact that the lines of light projected from these powerful reflectors are so well defined and do not become diffused until they reach a great distance. You must have, of course, a cloudy night and a certain proximity of the clouds to the earth, because at too great a distance the words would be illegible and at too close a distance they would be presented to the view of a comparatively small circle of people. The whole thing is simply a stereopticon on a large scale, with a light sufficiently intense and focused to reach the cloud canvas at a proportionately great distance. The subject is entirely new to me, but the applications of electricity nowadays are so diverse that I don't believe the electrician lives who is familiar with everything that is being done."

Dr. Schuyler S. Wheeler also declared that advertising on the clouds was perfectly practicable. "You have noticed, of course," Mr. Wheeler continued, "that the clouds over the city will reflect at night a red glare, and so anything that offers resistance to the transmission of light will develop it so that you can see it. The search light on the tower of the Madison Square Garden, for instance, shows much more clearly on a cloudy night than on a clear one. You have noticed also that if you are sitting in a room in which there is dust in the air, if a ray of light comes in through the blind it is at once visible, while if the air was perfectly clear the light would hardly be perceptible.

"The object in this use of the search light is put on a sheet of glass, leaving the parts representing the picture clear, and making the rest black, so that it will let out the light in the shape of the picture and in the colors of the picture also. The preparation of the apparatus would be exactly the same as that of a lantern slide, except on a much larger scale, unless special lenses were used. There is nothing novel in the principle of the thing, although similar experiments have never been made in this country. It is simply a very powerful magic lantern, and using the clouds instead of a sheet. By this use of the search light you could have dissolving figures on the clouds, giants fighting each other in the sky, for instance, or put up election figures that could be read twenty miles away."

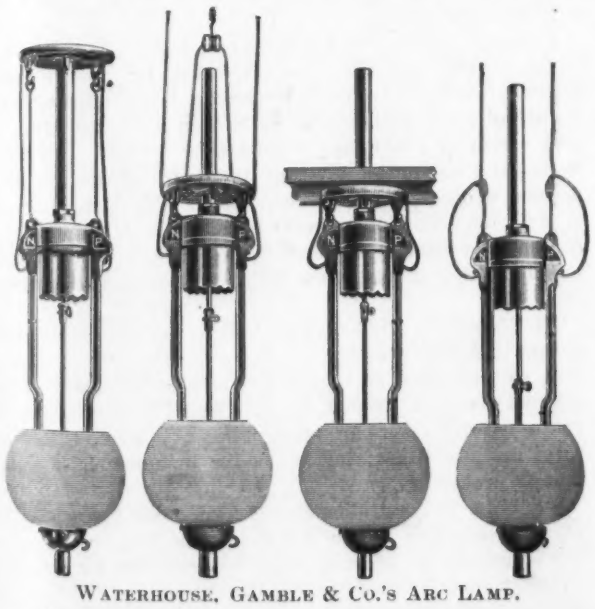
Prof. F. B. Crocker, of Columbia College, said there was no doubt of the fact that a powerful search light, working on the principle of the magic lantern, would make an image on the clouds that would be visible. "There is no theoretical or practical reason why it should not be done," the professor continued. "It would be a very striking application of the electric light on a large scale, and would be very effective as an advertising agency. There is no obstacle in the way of using the search light for advertising on the clouds, except the distance of the clouds from the earth and the particular kind of clouds necessary to have—clouds of a certain form and character and at a certain distance from the earth. At a very great distance it would be difficult to illuminate them; and if they were too near, the illumination would not show over a sufficiently wide area.

"Search lights can be made to give a strong illumination at a distance of a mile, or even more. Search lights can be seen 20 miles or more if thrown directly on the eye, and ordinary lighthouses can be seen 20 miles, but to illuminate clouds so that the reflected light from them may be seen is another matter, and the distance must be very much less. I have no doubt whatever, as I say, as to the practicability of this method of advertising. The search light apparatus and the rest would not cost more than a few hundred dollars, and the running expenses would not be very great."

Waterhouse, Gamble & Co.'s Arc Lamps.

Messrs. Waterhouse, Gamble & Co., 45 Broadway, New York City, have recently placed upon the market an improved arc lamp which is intended for use on either arc or incandescent circuits. This lamp is the invention of Mr. Addison G. Waterhouse, of Hartford, Conn., who has been identified with electric lighting since its earliest introduction. This lamp is waterproof, so that no hood is required when it is hung outside. It is superior in its mechanical and electrical construction, perfect in alignment, interchangeable in all its parts, strong and compact, yet of light weight, ornamental in design, and free from the usual defects which often cause so much trouble in lamps of this class.

The armature of the lamp mechanism, as its pull on the clutch is in an exactly perpendicular line so that all



WATERHOUSE, GAMBLE & CO.'S ARC LAMP.

side friction or necessity of transmitting motion through pivots is avoided. The clutch is made very durable, and by the assistance of an atmospheric clamping device a steady and fine feed is secured, making this lamp particularly desirable for use on incandescent circuits. The globe holder is dust-proof for inside work, and well drained for outside use, and so made that the attendant can clean out the globe without unscrewing it. All parts are made to an exact fit, and the lamps are designed for quick inexpensive changes; for example, if a customer has purchased lamps for incandescent circuits and desires to change them for arc circuits he can easily do so by purchasing a new set of works, which can be placed in the former without unhanging the lamps. It is also a very simple matter to change from full arc to half arc or vice versa, which is done by removing the magnets and substituting another set, or the size of carbon may be readily changed from 7-16ths to ⅝th or vice versa. The accompanying illustrations show the form of this lamp and various ways of hanging it, and it will be seen that it possesses considerable flexibility in this respect. The lamp is is experiment, and it has operated very successfully in actual use in many different places and under various conditions.

Carpenter Rheostats.

The accompanying illustrations show some of the apparatus manufactured by the Carpenter Enamel Rheostat Company, of Bridgeport, Conn. This company is making rheostats of every style and size, from a small plate 4 × 4 inches, with a resistance of over 2,000 ohms, to a rheostat capable of continuously absorbing 80 ampères and 500volts.

In Fig. 2 is seen a 40 k. w. field rheostat whose remarkably small size is clearly shown by the foot rule below it, A large motor starting rheostat is made in sizes of from 7 to 100 k. w. A theatre dimmer or rheostat for controlling 160 16-c. p. lights is shown in Fig. 1.

FIG. 1.—CARPENTER RHEOSTAT.

All those familiar with theatre electrical work appreciate the fact that some of the most dangerous, troublesome and clumsy electrical wiring done to-day is that which connects the rheostat switches with the boxes of wire coils, which are usually placed at a distance from the switches. The Carpenter company's theatre dimmer has the switch contacts mounted on the rheostat plates, so that no connecting wires of any kind are necessary. There is absolutely nothing but metal and enamel entering into the construction of the apparatus, excepting the wooden

FIG. 2.—CARPENTER RHEOSTAT.

handle on the switch lever, so that the fire risk is a minimum. The space occupied is no more than the switch part alone of former theatre dimmers.

An Ideal Central Power Station.*

BY C. J. FIELD, E. J. COOK AND F. BOURNE.

Unit of Power.—The unit of power to be selected for the central power station is one of the first and most important elements to be considered after deciding on the capacity of the station. We have selected for this ideal station 6,000 h. p. as the total capacity. The number of units in any power station should be the fewest consistent with safe and economical operation of that station. Experience has too often proved that power stations have been divided into too many units.

In the size of station we selected, we believe a 1,000 h. p. unit to be one which fulfills our requirements in every respect, both for safety and economy in operation.

Direct Connection or Belting.—The problem is still in the minds of many people whether to use generators directly coupled to engines, or belted as in the earlier type of station. The relative space required is, roughly, as two to one; in other words, a belted plant would require about five square feet of floor surface per horse-power as against two and a half square feet with direct connection plant. This means a saving of one-half the cost of real estate in building and also concentration of the power for handling. On the other hand, we have not secured flexibility of connection between the engine and generator, which we have in the belted plant, and the relief to the engine which is afforded by belt against the shocks of short circuits, etc. Ample fly-wheel capacity is one of the most important requisites for such an engine and ability to withstand direct shocks of short circuits and overloading of the generators.

*Abstract of a paper read before the Chicago Electric Club.

The power station building is a factory for producing a commercial commodity, and should be treated in that sense. The design of these buildings is too often placed in the hands of local architects, inexperienced and unacquainted with the requirements of such a building, and we find as a result many power stations in which the machinery has to be placed to fit the building.

Building Specifications—Excavation.—Excavate the entire space under the engine room to a depth of 10 feet, so as to get clear head room of eight feet in basement. Excavate for all side, cross and gable walls, all foundations, and also central space between boilers to form a basement under the boiler room for ash and coal handling apparatus, flue and pipes.

Foundations.—If ground is good, lay base of concrete (four broken stone, two sharp sand, one hydraulic cement) and make footing courses of brickwork, or coursed rubble masonry of good, firm building stone, laid in cement mortar of three parts sand to one part cement. In case piling is necessary, test piles should be driven on different parts of the property in order to determine the bearing capacity of the pile under the conditions present, noting the amount the pile sinks under the last blows of the "monkey." Allow a factor of safety from 4 to 15, depending on the conditions present. Piles should be of hemlock or spruce, perfectly straight and round, a 40 foot pile having not less than a 12 inch butt—the piles, after being driven, to have heads sawed off below the mean low water to a uniform level; all piles in water to be capped with granite foundation stone, while those with heads in earth to be capped with a grillage of 12 by 12 spruce and 3 inch plank timber, and the whole filled with concrete well rammed. Lay foundation proper on this grillage.

Walls.—All walls should be of brickwork from 16 to 20 inches thick, with pilaster at each roof truss, having at least eight inches projection and 24 inches face. Carry these to a height of at least 25 feet, so as to allow clear head room of at least 20 feet below the traveling crane in power house. All brick should be burned and should have clean, sharp edges, no salmon or light colored bricks being allowed. All brickwork should be laid in cement mortar. The cement should be Dyckerhoff's or English Portland. All bricks in the face of the wall should be selected. All joints should be pointed. Pilasters on side walls of engine room should be built out by offsets and capped with stone binder for carrying rails of traveling crane. Set side ventilators in walls near ground line.

Roof.—The roof should be iron truss, riveted type, furnished with iron louvre, with side ventilator that can be operated from the floor. The top of louvre should be furnished with hammered glass. The roof should be covered with Norway pine plank, splined and then covered with black slate of good quality laid with not more than five inches to the weather. All flashing around walls and all gutters to be of 16-ounce copper. The whole to make a weather-proof job.

Engine Floor.—The engine floor should be of two layers of plank, the first of yellow or Norway pine splined with hard wood, this floor to be covered with about one-eighth inch of plaster, and with a second floor of seven-eighths inch second quality maple laid at right angles to the first. The first plank to be not less than eight or more than 12 inches, and securely bolted by hook bolts at every beam to the iron I beams. The second floor should not be over four inches in width and should be blind nailed. All plank should be neatly fitted about all foundations and hand planed and smoothed an finished with two coats of boiled oil put on warm.

Engine and Boiler Room, Basement Floor.—This floor should be made of not more than six inches concrete, well rammed and graded to drain, and finished by means of fine stuff floated smooth by means of hand trowel.

The boiler room floor between boilers should be made of steel I beams covered by means of cast iron plates of suitable pattern. All other parts of the fire room should be finished by means of concrete cement, same as basement.

Painting.—All woodwork should have not less than three coats of first-class lead paint ground in oil; this includes under side of roof, windows, doors, etc. All iron should receive two coats of metallic paint, one before erection and one after the structure is completed.

ENGINE SPECIFICATIONS.

Duty.—Electric railway and power work. All parts extra heavy.

Type.—Vertical, three crank, triple condensing.

Power.—Ability to develop for short periods of time a power of at least fifty per cent. above its rated capacity without dropping off in speed of revolution.

Regulation.—Regulation effected by means of a shaft governor acting on the valves of high pressure cylinder alone. Governor designed to cut off all lead of steam valves when practically all load is thrown off the engine. The momentary variation of speed of revolution (*i. e.*, the variation that would take place in three to five seconds) not to exceed 2½ per cent. when one-half the rated load of the engine is thrown suddenly on or off; indicated by means of a tachometer belted direct to the engine shaft.

Economy.—Economy, with condenser under average economical load, to be not more than fourteen (14) pounds of steam per indicated horse power per hour with 150 pounds initial steam pressure and 26 inch vacuum. This assumes that the steam is not to exceed 2½ per cent. of moisture and the first cylinder steam jacketed with full boiler pressure.

Valves.—To have four valves to each cylinder. The steam and exhaust valves to be independent, with exhaust valves moved by separate gear. Valves on high pressure cylinder to be either of the piston type or flat valve, balance, with pressure plate. Valves on intermediate pressure and low pressure cylinders to be of flat type, either four ported, partially balanced grid-iron or Corliss type.

Clearances.—Clearances not to exceed eight per cent. in the high pressure cylinder and three per cent, in the intermediate and low pressure cylinders. Cylinders to be protected by non-conducting covering, such as magnesia or asbestos and steel or cast iron jackets for finish. Cylinders in receivers to be protected by means of relief valves.

Frames.—To be cast iron girder-type "*A*" frame.

Shaft.—Of best forged steel with built up cranks and counterbalanced in one piece.

Bearings.—All main bearing surfaces such as shaft bearings, slides, etc., should be water jacketed.

Gallery.—Engine to be furnished with one or more galleries from which it can be operated as well as from the floor, and offering easy and safe means of access for lubrication and inspection.

Lubrication.—Engine to be provided with either oil or grease lubricating apparatus, such that it can be lubricated as thoroughly when in motion as when at rest. Each cylinder to be provided with sight feed lubricators as well as oil pumps, and the entire engine, if oil is used for lubrication, to be fitted with sight feed lubricators. In the case of grease lubrication provision is to be made to allow any part to be lubricated individually, as any system of grease distribution from a common centre involves the possibility of stoppage of tubes with dirt or foreign substances.

Fly or Belt Wheels.—The engine should be provided with intermediate wheels between the cylinders where possible, so as to bring the shaft as near the condition of uniform load as possible. Allow 48 pounds per indicated horse power in case of electric lighting and 70 pounds in electric railway and power work for weight of fly wheels. Rim of wheels on a basis of 5,000 feet velocity of the rim per minute. Piston speed 650 feet per minute.

Rotative Speed.—A mean figure between a high, or what is commonly understood by high and low speed; say 120 revolutions per minute on a 750 h. p. triple.

Remarks.—The power the engine should develop when connected direct to an electric generator should be determined by the capacity of the generator first, and also its capacity for overload. The engine should have an ultimate capacity approximating that of the generator.

Experience has proved that an engine of large power can be regulated closely as regards speed of regulation, by means of a shaft governor acting directly on a properly designed valve and gear on the high pressure cylinder alone of a triple expansion.

One of the most vital points of an engine for electric service is that of main bearings. They should have a surface velocity of not exceeding 350 feet per minute, with a mean bearing pressure per square inch of projected area of journal of not more than 80 pounds. This is considerably within the safe limit of cool performance and easy operation. If the bearings are designed in this way, it would admit the use of grease on all the main wearing surface, which in a large type of engine for this class of work we think advisable.

(*To be continued.*)

Micanite and Its Application to Armature Insulation.*

BY EDWARD P. THOMPSON, M. E., FOR CHARLES W. JEFFERSON AND ARTHUR H. S. DYER.

An armature and its commutator consist of the combination of two elements; namely, electric and magnetic conductors and insulators. In the earlier days of armatures, the electrical and mechanical dimensions and proportions of the conductors were considered of prime importance. The first armatures were small and the electromotive force low, and consequently little attention, comparatively, was given to the element, insulation. Lately, simply paper, cloth, convolutions of ligatures, or these materials impregnated with shellac or similar insulating varnish or paint, were employed for the purpose of preventing leakage or short-circuit. To remove the solvent of the shellac, the armatures were baked for twenty-four hours. Judging from the variety of materials used at present, and the changes from one material to another, it would seem that the insulators are now receiving their share of consideration, while the core, wires, commutator-sections and other conducting portions are secondary details. Why so much difficulty with armature insulators and so little with other insulators, such as line insulators? Because, in the former, not only must the material be of extremely high resistance, but also unaltered under the effects of heat and must be crowded into very small quarters. Space must be economized. If the electric current or heat alone were present and if space were not so much limited, the problem would be easily solved. It yet remains to be proved that any known substance is absolutely a non-conductor—nor is the resistance of a given conductor constant. Unfortunately for the armature constructor, the worse the conductor, the less the resistance with increase of temperature. An extra current is produced in metals upon variations of current. A diminishing of current occurs when first entering a substance of high resistance. Finally, and gradually the current becomes constant. This action for convenience is often called polarization. As this property is noticeable only in long lengths of the insulating material, it has little bearing upon any of the armature elements other than in connection with the covering of the wires. The substance possessing the property of polarization in a marked degree is gutta percha.

Paper or fabrics by themeselves, should never be used as an insulator, because when moist they conduct a current so well that they may properly be termed semi-conductors. A coating of shellac or oil upon almost any substance enormously increases its resistance, and protects porous and deliquescent substances from water. Paper thus covered, serves with machines of low electromotive force, the purpose of preventing leakage, but, by no means perfectly in practice, with large machines. Its advantages are more in the nature of convenience and cheapness than of efficiency.

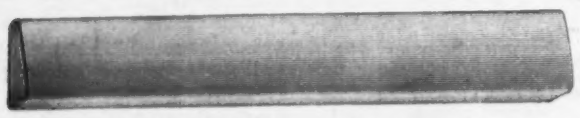


Fig. 1.—Micanite Tube for Insulating Core Projections.

Paper which has been thoroughly dried is of very much higher resistance—so high that it falls under the head of non-conductors, and therefore, the shellacs should not be applied until after the paper has been subjected to a thorough drying process.

It is a peculiar property that a given substance in a compact condition is of very marked higher resistance than when powdered or comminuted; for example, pulverized glass is a semi-conductor, while sheet glass is as high in resistance as silk. This property has been noticeable in armature practice. If the insulating material is cracked here and there, it is unfit for armature use. The cracks are in the nature of interstices between the particles of a powder, and at the cracks the material is in part ground. The explanation may lie in the distinction that the pulverized material has more surface, or that damp air exists in the spaces between the particles, or that a spark can traverse a gas better than a solid, or that each particle becomes coated with a film of moisture. The last seems the most probable, because the best surface concentrators of water usually exhibit the property most strongly.

The locations of insulation in an armature are between the armature discs to prevent eddy and Foucault currents; between the core and the windings to prevent the current from short-circuiting the coils through the core and burning out the armature; between the commutator-sections to prevent leakage from one coil to another; over projections or in grooves in the core; and around the wire to guide the current in convolutions. All these parts, even in the best made armatures become more or less abnormally hot. Means have been planned and sometimes put into practice for cooling the parts, and thereby saving the insulation. One method consists in constructing the armature after the style of a fan or with large radiating surface; another, in equipping a device to prevent the sparking at the commutator, and again, in using cooling insulating liquids. With whatever precautionary means the machine is equipped, the parts, either accidentally or through inefficiency of means, will become abnormally hot. The machine will be injured if combustible materials form the bulk of the insulator. The materials of an ideal armature consist of copper, iron, and a heat-proof and water-proof non-conductor. If the material is combustible, or altered in its chemical nature, by heat, its resistance is changed and generally lowered. Manufacturers of incandescent lamp filaments know that complete carbonization cannot take place except at a very high temperature, like 3,000 degrees Fahrenheit. An armature may rise to 500 degrees. At this temperature, easily carbonizable materials, such as linen, cotton and other forms of cellulose are weakened, blackened and the resistance reduced. Shellac, although blackened at this temperature, is converted into those compounds whose resistance is not lowered. Shellac forms an exception therefore, in being charred by such a temperature without reduction of resistance.

There is a greater detriment than chemical change by heat. The material cracks, becomes somewhat comminuted, and the resistances, both mechanical and electrical, are therefore greatly reduced. If paper or cloth, or even shellac is depended upon as the insulating material rather than as the binding material, it is not electric proof; because principally, it becomes, when charred,

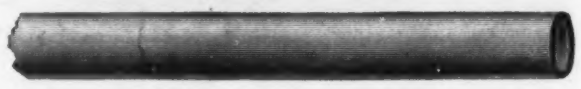


Fig. 2.—Micanite Tube.

fractured at numerous points, if not completely pulverized. As to why shellac is not appreciably lowered in resistance by partial carbonization may be because it is an animal substance.

One of the most important attributes of an armature should be its rigidity. It should be like a rock in this particular. If the insulation should consist of a soluble material, for example, and the same dissolved out after the completion of the armature; or of some material that would be reduced in size by heat; then the wire and bolts would soon become loose from the rapid rotation and vibration, and finally the armature would be useless. Change in volume of the insulators has caused nine-tenths of the armature break-downs.

In the matter of insulation between the discs it was found that oxidized or rusted laminated armature discs would insulate without any addition of paper or similar insulating films. The only difficulty with such a construction is one of degree. Iron rust insulates, and it is heat-proof; but it does not insulate sufficiently to compensate in most instances for its simplicity and cheapness, and besides it is not applicable to any other part of the armature than between the laminae of the core. The great advantage lies in the extreme thinness of the oxide coating, whereby a large amount of iron is obtained in the core. A modification has been suggested, which consists in placing thin mica sheets between every half-dozen of the discs. Again iron wire, or ribbon rusted has been employed for armature cores. The wire or ribbon is formed into a ring, around which is the electric conductor. Another modification consists in "case-hardening" the iron, and also in japanning the surface. As to commutator insulation, natural mica sheets have been almost universally employed.

If it were not for the matter of mechanical construction and heat, shellacked glass would make a good armature insulator. It could be molded into any form and made of any degree of thinness. Its objections, however, are well known. Very gradually, and more so than would be conjectured, mica made its appearance in armatures. The introduction of mica into practice appears to have been brought about in the following manner: An accident would happen to an armature, and before the next night it must needs be repaired. In order to make the temporary remedy, mica sheets or bars would be interposed. In the case of subsequent accidents, the portion repaired by mica was the last to yield. Therefore it was proposed to build the armature primarily with mica. But this change took place very, very gradually, but surely. Manufacturers of stoves, the leading houses being also importers of mica, soon experienced a growth in the mica department of their business, until at present some import more for the electrical industry, especially for armature use, than for stoves. Why it was not employed from the first, no one could positively assert, otherwise than to guess that no one probably thought of it, or insulation was not considered of much comparative importance, or cheapness of material in construction was allowed to counterbalance efficiency of action and durability.

Of all substances, mica probably is the best material for use in armatures, if it is desired to obtain not only efficient electric insulation, but also durability under the influence of heat. The highest temperature to which an armature is subjected, even by short circuit or bad construction, will have no injurious effect upon mica. Mica, thick or thin, may be held in a gas flame without cracking, burning or melting. It remains unaffected. The reason of this is better understood when it is remembered that it consists of aluminic silicate, containing also potassic, sodic and lithic silicates, and some ferrous and ferric and manganic oxides. Its chemical constitution varies.

One quality of mica is that which is commercially termed amber mica, and is usually mined in Canada. It is so named from its appearance and not because it is amber or in any other way similar to it than in its color. India mica is a commercial form noted for its uniform cleavage, great thinness of its laminae, flexibility without fracture and its resistance, which is much higher than that of amber. Carolina mica is another variety. It is obtained in sheets in the western part of North Carolina. It is the best mica for stoves, but it is too hard for electrical purposes. Mica occurs in so many specific forms that particular names have been given to it.

Muscovite is one of the most common varieties. It occurs in different colors, namely, a dark green, yellow, brown, white and gray. This is the form found in small scales in granite, gneiss, and mica schist, and at the same time it occurs in larger, tougher sheets than any other form. A complete scale is irregularly hexagonal in shape. Lepidolite, or lithia mica, has a pearly lustre, as distinguished from the vitreous luster of muscovite. Its scales are usually very small, and it is found in limited varieties of granite and gneiss. Cryopholite is a subvariety of lepidolite. A characteristic feature of the form meionite consists in its occurring much cracked within. It has been found in geodes. Biotite is a form found in volcanic rocks in small scales. It contains much iron and magnesia compounds. Phlogopite occurs usually in limestone. Its subvarieties are aspidolite and manganophyllite. A very brittle variety is lepidomelane. It is also practically opaque. Its subvariety is astrophyllite.

The insulating power of mica is superior to that of any other substance applicable to armatures. An advantage peculiar to itself, is its even, laminated structure. How wonderful is the thinness of its individual layers! A piece of ordinary writing paper is about .005 inch. Mica layers have been obtained of a thinness of .00003 inch. Mechanical difficulties prevent its being split thinner. By pasting it upon a hard surface and splitting it off as much as possible, the remaining fragments are so thin as to become beautifully iridescent. The builder of armatures can therefore split the sheets into any desired and uniform thickness with great ease and accuracy. An interesting property of mica and one not generally recognized, is its homogeneity of structure and clear transparency, although so black when thick. The writer used a piece one-quarter of an inch thick for observing the late solar eclipse. The effect was better than with smoked glass and as efficient as black glass much thicker.

A valuable property of mica in connection with commutator insulation is its proper degree of hardness, whereby it does not wear away too rapidly under the action of the brushes. If rubber were used, for example, even if it did not burn, yet it would wear off and sparking result, because the commutator surface would not be truly cylindrical. The brushes would be set into vibration. Again, mica is capable of the finest pulverization, so that any wearing which does take place does not result in the liberation of gritty particles, which would also

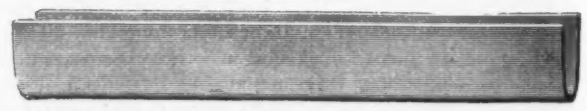


Fig. 3.—Micanite Armature Slot Insulator.

cause sparking. Such mishaps occur with hardened artificial plastic insulators. The insulation should be just so thick that the current cannot jump across from one section to the other.

Although so superior for armature insulation, mica is, in its natural structure, accompanied by certain objections, which, in trying to overcome, were more serious than had been anticipated, as it was not until after a long series of trials that a successful article was produced, and not until a novel apparatus for cheapening the process of manufacture was devised. The apparatus is now in operation on a large scale. The description at present is confined, however, to the article, and to full information of its structure, manner of using and properties.

The objections alluded to are: Mica, as found in nature, occurs in flat sheets only. It has a high degree of elasticity, so that when once bent and released, it assumes its original form. If folded, its brittleness causes fracture. If the natural sheets are compressed in a mold, to try to form armature insulator heads for instance, it is completely broken up.

Secondly. Natural mica sheets correspond financially to plate glass. The larger the sheet, the higher the cost per square inch. Mica in small pieces, from four to six square inches, is exceedingly abundant and very cheap. It is often called waste mica, because very limited in its uses, and consisting often of trimmings from larger and more useful sheets. In medium and large sizes of armature, the naturally built up mica is so expensive as to be objectionable, although not so much so as to entirely prevent its employment.

Thirdly. Between the hundreds, nay, thousands, of thin layers, damp air can enter, and also water, accidentally, which cannot easily or effectually be removed.

Fourthly. Mica splits so easily that handling causes injury.

Fifthly. Mica cannot be cut transversely to advantage. The edges are unworkmanlike, being ragged and jagged. Neatness in drilling, sawing and turning is difficult.

Among the attempts which have been made to over-

*A paper read before the American Institute of Electrical Engineer

come these objections are those involving the use of pulverized or comminuted mica, which is mixed with a liquid cement and stirred into a paste. While still soft, the mixture is rolled or compressed into any desired form, as if consisting of so much plaster-of-paris. In order to give it sufficient strength, one-third of the product is cement. The mica sparkles here and there on the surface, as it glitters on granite. This article should be called a cement insulator, and not a mica insulator, because the current can flow in a straight circuit through the plate without encountering any mica. The cement forms numerous rectilinear paths for the current independently of the mica; and therefore the product in no sense is an equivalent of mica.

A modification of this type of insulator consists of a coarse and thick textile fabric, whose pores and meshes are filled with a mixture composed of comminuted mica and a suitable adhesive substance. Another consists of finely divided asbestos mixed with pulverized mica, silicate of soda, and sulphur compounds. It is molded by pressure into any desired form.

The comminuted mica-cement type is useful in trolley wire supports and similar insulators, but for dynamos it is useless not only for the reason stated, but because of its softening and running under slight heat, being so necessarily rich in cement. If the cement is that kind that chars, the mica crumbles apart. Mineral powders have been mixed with it, to render it more fireproof.

An example of the manner of using non-comminuted mica between the core and the windings consists in covering the core with paper, laying sheets of mica over the paper, then laying on another sheet of paper, fastening the whole together by convulutions of cord or similar ligatures, and finally applying the coils. During operation, the paper and mica may shift from their positions, and thereby affect the rigidity of the armature as a whole. Again, the process of applying the pieces, and keeping them temporarily in position, requires repeated efforts and results in a display of crude workmanship.

The exhibits before you show practical results of work carried on for the purpose of overcoming the objections named.

Large Plates.—One of these plates is a yard square and .035 inch thick. Another is of the same size and 1 inch thick, and another about 4 inches by 12 inches and 1 inch thick. They have nothing to do directly with the armature; but could serve as foundation plates for a dynamo or motor. They are practically all mica. A natural plate of mica of the larger size would be a curiosity—a rarity. Any of the sheets may be cut up into any desired size and shape. The layers cling together much more tenaciously than in the natural plate. The path of least resistance from one side of the plate to the other is in a straight line, and a straight line intersects numerous mica sheets, and, therefore, the article is a mica insulator and not a cement insulator. These plates are made by such steps and apparatus that when subjected to heat in the armature, no injury whatever is produced.

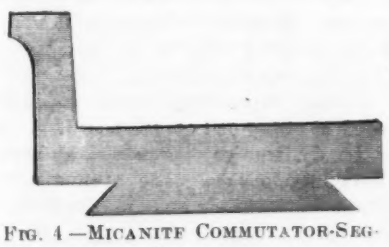


FIG. 4.—MICANITE COMMUTATOR-SEGMENT INSULATOR.

FIG. 7.—MICANITE WASHER.

Further, they are superior to a sheet of mica as it comes from the quarry, in that they do not absorb water or damp air; in that they are stronger to resist either pressure or tension; in that they may be neatly and easily sawed and drilled; in that they are enormously less costly; and in that they are of about the same resistance. By picking the exhibit apart, you can easily learn the structure. The mica of which it is composed is non-comminuted, but the pieces are exceedingly thin. The thickness is, by measurement, about .001 inch, i. e., about as thin as tissue paper. The sizes vary from 2 to 6 or 8 square inches. In each layer of mica, you may notice that the sheets overlap at their edges, and the cement between the layers is hardly noticeable. The former mentioned plate weighs about four pounds, and the latter over 100 lbs. It is a convenient quality in connection with mica that it can be split into pieces of the thickness required for the particular device under the process of construction. This property is also possessed by the plates exhibited. A thin and long knife may be caused to force its way in any of the many planes parallel to the surface, for the purpose of reducing the thickness or obtaining several thinner sheets from one thick plate.

Some tests were carried on to determine the relative values of these plates, and plates of comminuted mica and cement. Using the words of the electrician who originated and performed the tests, he says: "For the purpose of insulating armatures, any solid insulating material should possess considerable strength and should maintain its strength when submitted to a moderate degree of heat. One piece tested consists of ground mica and shellac, mixed together and rolled or pressed between plates to a uniform thickness. In order to test it, I placed it upon a steam-table and left it for a minute, at the end of which period I tested its strength by pressing the end of a piece of wire against its surface with very light pressure. The end of the wire, which was blunt and made of copper, easily pushed its way through the sheet and left a hole when removed. In removing the sheet from the steam-table it warped. The second plate consists of layers of sheets of mica, cemented together with overlapping joints. This sheet I placed on the same steam-table used for the other sheet, and after one minute had elapsed, tried to thrust the same piece of copper wire through the plate, but without success, though exerting all the strength that could be brought to bear upon it by my hand. After the sheet had been on the steam-table for five minutes, I placed it on a thick iron plate, laid a piece of the same copper wire upon its upper surface, put a second sheet of wrought-iron on top of it, and put the whole into a hydraulic press. It was then submitted to a pressure of 2,000 pounds per square inch for one minute, and the result was the flattening of the

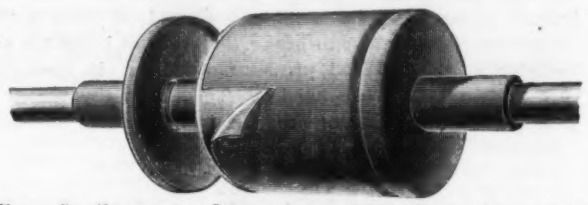


FIG. 5.—COMPLETE DRUM-ARMATURE CORE PROTECTED WITH MICANITE.

wire and a very slight crumpling of the mica sheet on the opposite side. The plate was then placed between two copper plates, and a weight of about four pounds placed on the upper plate. The insulation resistance of the plate was then tested and found to be 25,500 megohms. I have used similar plates, similarly prepared, in motors, upon which a load of 50 h. p. has been placed, the entire thrust of the motor being received by the plates, which in this case were less than one-sixteenth of an inch thick. The temperature was brought up to 650 degrees Fahrenheit, sufficient to burn cotton and melt hard solder without injuring the insulation."

Curved Specimens.—Similar remarks substantially, may be made about these, as about the large plates. Natural mica plates could never be given a permanent set, or molded into curved forms. The armature head consists essentially of an annular disk, provided with flanges around one or both peripheries. It is in one sense a continuous piece. The flanges, you may notice, are not made separably and then fastened to the disks. There are no joints. Some of the peculiarly curved forms are furnished in order to illustrate that the article may be manufactured in any imaginable form of uniform structure, and in single pieces of uniform properties throughout.

Tubes.—In order to show the unlimited forms into which the material may be molded, a tube several feet long is exhibited. It may be cut up for use in certain types of armature, or when long, for use on board ship, and in interior conduit installations in certain limited cases.

Stamped Forms.—The flat pieces of peculiar form could be made from the beginning in individual pieces, but it is much cheaper, if stamped from larger plates. Before using the large plates for any purpose where an exact thickness is required, they are burnished or surfaced off by machinery. Some of the plates before you are in the crude state, and little scales here and there can be peeled off. The others are so different as to resemble a metallic surface, and when struck ring like metal. Some of the forms are for large commutators. Others are flat rings for field-magnet cores. The very irregular flat pieces are for certain types of commutators. On account of the almost metallic qualities the product can appropriately be termed an "insulating metal." For convenience, it is called micanite.

Commutators.—In equipping a commutator with this material, it is necessary to know something which has been learned by early users, only through experience. The insulating and metal sections are put together in the usual manner, and the whole is heated to a temperature higher than that which it will reach in actual practice. While still hot, the elements are clamped tightly together.

Among the exhibits, is a mass of odd pieces of mica sometimes called waste mica; also, you will find similar pieces split as fine as possible. These are the result of the

. . 6.—MICANITE RING FOR COMMUTATOR.

first operation. The next step consists in putting them together in the manner shown in the exhibits; that is, in layers with overlapping edges. Between them are layers of a cement having those qualities which fit the product for the purpose intended. Until only recently, these pieces were always laid on by hand. One girl could produce only one cubic foot per day. Now, one girl can do the work which formerly required twenty. The girl feeds the machine, and it does the rest. The amount of cement employed is practically infinitesimal, because while in a plastic condition, the mass is subjected to such pressure that a mere trace remains, and yet sufficient to obtain proper adhesive qualities. From the beginning to the present, improved processes and new machinery have been required.

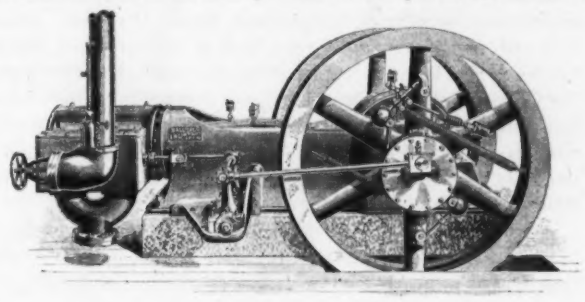
Dr. James Bowstead Williams has carried on a long series of tests upon the comparative specific resistance of mica and micanite. The data and results are as follows:

The conditions of the tests were absolutely the same in all cases. The potential was constant, being over 3,000 volts. A dynamometer served to maintain the same pressure for different materials. All the samples were kept at the same temperature and under the same hygroscopic conditions for several days. Samples were of uniform thickness. The best samples of micanite gave approximately the same reading as the best India mica, indicating that the resistance of micanite is equal to that of the best commercial mica.

New Heavy Duty Electric Railway Engine.

The engine shown in the accompanying illustration was designed by the Ball Engine Company, Erie, Pa., especially for electric railways and electric welding, and possesses all the requirements for that kind of service. Its great weight and strength, with the even distribution of metal, especially fit it for heavy duty, varying loads and long continuous runs.

The frame of the engine is massive and heavy, and internally ribbed so as to give the greatest attainable stiffness. The crank shaft is forged out of a solid steel ingot of the best quality, and is of large diameter and great strength. The connecting-rod and straps are forged out of steel ingots, and are of a new design, combining strength with efficiency. The main bearings are unusually large, and are so arranged that both the vertical and side wear of the liners may be taken up. The main bearing liners are genuine babbitt, carefully scraped and fitted, and, as they are made removable, they can be quickly and easily taken out and replaced with new ones if necessary. The crank-pin boxes are lined



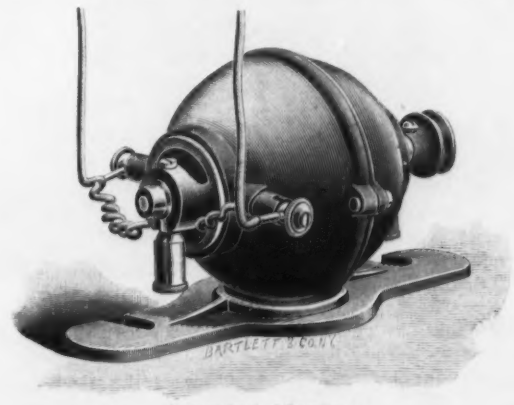
BALL ENGINE.

with genuine babbitt. The crosshead boxes are made of pure copper and tin. The crosshead is a steel casting, with very large bearing surfaces, and is babbitted on the four faces with genuine babbitt. The crosshead pin is tool steel, and the piston-rod a fine quality of crucible steel. The oiling devices are of the most improved form, and all fittings are complete and of the best description. The regulation by means of the improved governor is such that the engine has shown in practice perfect regulation under conditions where the variation in load on the generator, from zero to the full capacity, has occurred in less than five seconds of time.

The Lundell Small Slow-Speed Motor.

In response to a demand for a small, slow-speed motor which is adapted for sewing machine and light work of that character, the Interior Conduit and Insulation Company has brought out a small, slow-speed Lundell motor for 110-volt and for 4-volt circuits, which we illustrate herewith. Special attention is called to these small motors, which will be found superior in all respects both as to quality and design.

These motors are wound for both 110-volt circuits and 4-volt battery circuits, and their extremely slow speed, 1,200 revolutions per minute, their efficiency and torque is remarkable for motors of their size and capacity. They are mounted firmly on a base that may be secured to the floor



LUNDELL MOTOR.

or any substantial support and the screw slots in the base provide a ready means for quickly tightening the belt. These motors run absolutely noiseless, are fitted with self-oiling and self aligning bearings and are neatly finished in black japanning with red and gold striping.

These new motors complete the line of Lundell motors recently placed upon the market by the Interior Conduit and Insulation Company, from $\frac{1}{6}$ h. p. to 5 h. p. capacity. The above small motors are used exclusively by the Automaton Piano Company for operating the mechanism of its automatic piano.

Resolutions of the Chicago Electric Club.

The Chicago Electric Club has passed the following resolutions in memory of Geo. H. Meeker and M. M. M. Slattery:

Whereas, It has pleased the Almighty to remove from our midst two honored and beloved members of this club, and

Whereas, We acknowledge the wisdom of God while we cannot fathom his His infinite designs,

Resolved, That we feel in the demise of George H. Meeker and M. M. M. Slattery, the club has lost two members of whom all were justly proud, as fellows and friends, genial and upright men, whose removal will leave a blank space in our circle, and whose presence will be missed at our social and literary meetings.

Resolved, That we deeply sympathise with the relatives of the deceased, and earnestly commend them to the Father of all for the consolation He alone can give.

Resolved, That copies of these resolutions be properly certified and transmitted to the families of the deceased, and published in all electrical papers.

Commercial Electric Company's Dynamos and Motors.

Constant potential motors and dynamos of moderate capacities may now be fairly said to have become a staple article of manufacture. In every large town and city hundreds of these machines may be found doing the various kinds of work for which they are adapted, satisfactorily and efficiently. The line of machines, from ¼ h.p. to 50 h.p., manufactured by the Commercial Electric Company, of Indianapolis, Ind., under the patents of Mr. A. D. Adams, are designed to meet the exacting requirements of this extended use.

The following are some of the characteristic features of these machines: All field magnet frames are made of forged, wrought iron throughout, no cast iron being used. As a result of this construction, a lighter, more sightly and more efficient machine is obtained. Gramme armatures of large diameter are used in machines from ¼ h. p. to 10 h. p., giving ample room for the many turns of wire required on these small machines for high pressure and insuring non-liability to burn-outs and ease of repair. Armatures of machines from 1 to 10 h. p. capacity are wound with but one layer of wire for 110 volts, and but two layers for 220 and 500 volts, another feature which renders burn-outs unlikely and repairs easy. The point of commutation is constant under all changes of load within the capacity of the machines, due to the great strength of the field magnet and few turns of wire on the armature.

All starting boxes and rheostats are constructed entirely of incombustible material, with slate fronts. All terminal boards, for mounting connections on motors and dynamos, are of slate, and all binding screws and binding posts of ample current carrying capacity and mechanical strength. All machines of one h. p. and over are provided with insulating, sliding bases and belt tighteners.

Barnes Friction Clutch Pulleys.

The accompanying cuts represents the principle of one of the latest improvements in the line of friction clutch pulleys and cut-off couplings manufactured by the J. H. & D. Lake Co., of Hornellsville, N. Y.

Fig. 1 affords a sectional side view of the Barnes screw lever friction pulley in released position, showing the driving hub keyed to the shaft.

Fig. 2 is a sectional end view describing the friction hub encircled by friction ring, the former of which is cast in one solid piece with the pulleys. Projecting lugs on opposite sides of the driving hub of the ring drop into lugs, or lug cavities, of the friction ring; and when the clutch is on these lugs take all the driving power. This is an improvement over the old bolt fastening system, the bolts of which are more liable to be affected by the twisting strain upon the hub from the friction of the clutch. At the extreme top and bottom of Fig. 2 is shown a view of a simple device which evades the use of much complicated macinery and more than substitutes the corresponding complex parts of some previous inventions. It is a lever nut on each side of the friction ring, one-half of the nut being cut with a right thread and the other half with a left thread. Sufficient space between opposite sections of the ring is given for contraction or clutch, which is effected by means of right and left thread screw bolts entering the lever nut from opposite sides, secured by set screws. Duplex levers are attached to

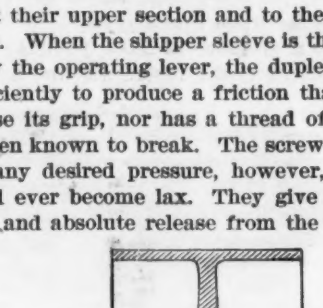


FIG. 2.—BARNES CLUTCH.

these nuts at their upper section and to the hub at their lower section. When the shipper sleeve is thrown against the flange by the operating lever, the duplex lever turns the nut sufficiently to produce a friction that was never known to lose its grip, nor has a thread of these screw bolts ever been known to break. The screw bolts are adjustable to any desired pressure, however, in case the clutch should ever become lax. They give the pulley a positive grip and absolute release from the hub by each

FIG. 1.—BARNES CLUTCH.

opposite shift of the operating lever, without the use of springs. The Barnes screw lever friction clutch pulleys and cut-off couplings are adapted to both heavy and light work.

An Automatic Safety Governor Stop.

Some of the most noticeable improvements which the Sioux City Engine Works have made in their Corliss engines during the past year are a high-speed ball-bearing governor, a double wrist plate and an automatic safety governor stop.

The automatic safety governor stop, which is the invention of Mr. James Barclay, is designed especially for Corliss engines, although applicable to all engines. It is attached to the governor stand, with direct steam connection to the valve port of the cylinder, and is regulated entirely by the motive power of the engine, thus making it positive in all its workings, and not subject to sticking. It is automatic, because the instant the engineer opens the throttle valve the steam acts on the lever in the face of the stop, the steam pressure forcing the lever from under the governor sleeve, when the momentum of the governor balls raises the governor. If anything should happen to the governor or stand the device will permit the governor to settle and stop the engine. When the engineer desires to slow down by shutting off steam from the throttle, the pressure is withdrawn from the lever, and it returns to its perpendicular position, the governor sleeve then settling on the end of the lever and the engine is ready to start. It is directly applicable to all Corliss engines now built or in use. It has been in practical use on many engines, and has fully demonstrated itself to be a device long sought for. It is manufactured and placed on the market by the Sioux City Engine Works of Sioux City, Ia.

A Handsome Switchboard.

One of the handsomest and largest switchboards in the world has just been completed at the Schenectady Works of the General Electric Company for the first station of the Edison Electric Light and Power Company of San Francisco. It is constructed of slabs of highly polished white Italian marble mounted on an iron frame, and is 56 feet 8 inches in length.

The board provides for the distribution of 2,200 kilowatts, or 14,666 ampères at 150 volts, from 12 generators of the General Electric Company's multipolar type directly coupled to triple expansion engines. Ten of these dynamos are of 200-kilowatt and two are of 100-kilowatt capacity, and all are arranged on the three-wire system.

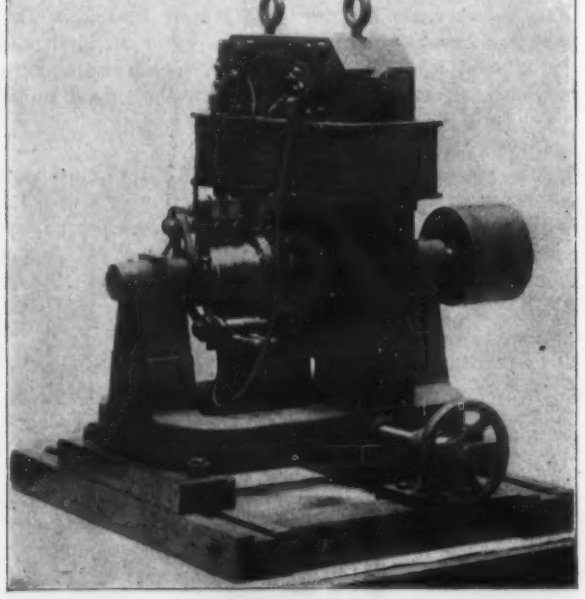
The main and auxiliary busbars run the entire length of the switchboard and are set in a rack in the rear. They are so arranged that they can be cut in two at the centre by means of heavy switches on the face of the board. This allows of the operation of the station under four different potentials at the same time. Provision is made for 24 feeders. Each feeder is equipped with two ampère meters, and three switches. Each switch has two blades, one for the main and one for the auxiliary bus, the positive and negative switches of each set being provided with safety catches. A novel feature in these last named switches is the mica covering for the fuse, which is hinged and can thus be readily raised where necessary for the insertion or adjustment of the fuse.

A special thirty-point indicator switch is mounted on the board, by means of which it is possible to read in the station the voltage at all the feeding points in the outside system. Each dynamo is provided with an ampère meter, a dynamo field regulator and two switches, each double-bladed, so that the dynamo may be thrown upon either the main or auxiliary busbar. The ampère meters are mounted on bases of marble similar to that of the board, and have highly finished brass covers with fronts of beveled heavy plate glass. The regulators are also fitted with white marble tops. Besides the apparatus already mentioned, the board is equipped with the necessary pressure indicators, and galvanometer switches.

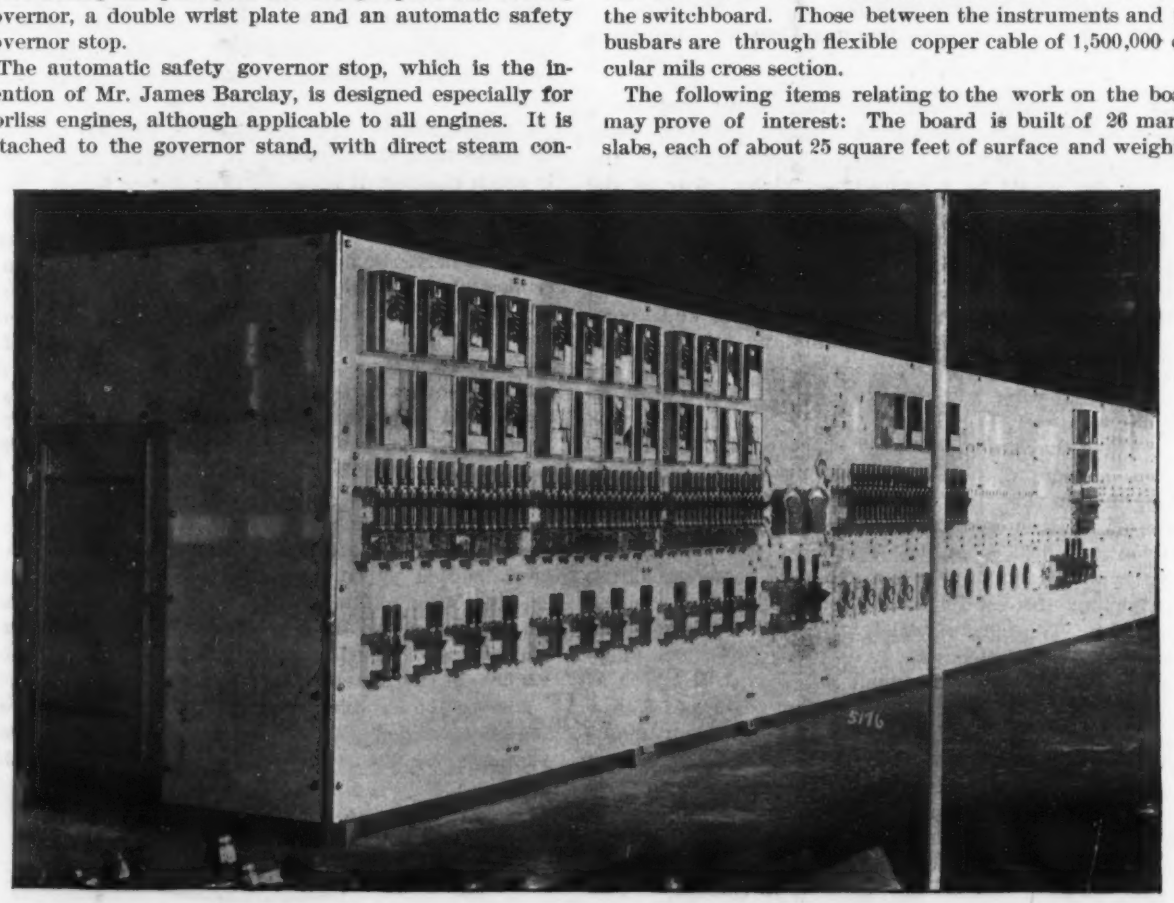
Two ornamental pillars supporting small auxiliary boards are to be erected at either end of the board. Upon these will be placed the dynamo galvanometers and pressure indicators. All connections are made at the back of the switchboard. Those between the instruments and the busbars are through flexible copper cable of 1,500,000 circular mils cross section.

The following items relating to the work on the board may prove of interest: The board is built of 26 marble slabs, each of about 25 square feet of surface and weighing in the aggregate over seven and a half tons. The weight of the main switchboard complete and fitted for the present requirements of the station is 37,000 pounds, and 5,000 pounds of copper connecting cables, 6,000 pounds of copper busbar and 10,000 pounds of high conductivity metal were used in its construction. Each dynamo switch of 1,500-ampère capacity weighs 150 pounds, each double-bladed feeder switch 100 pounds and the large busbar switch 200 pounds.

The cut shows the switchboard as it stood in the factory a short time before completion. When erected in its place in the station at San Francisco it will be further adorned by the addition of an ornamental cornice and baseboard.



COMMERCIAL ELECTRIC COMPANY'S DYNAMO.



GENERAL ELECTRIC COMPANY'S SWITCHBOARD.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Dec. 23, 1892.

New York General Financial Stock Market.—The demoralization fully set forth in these columns last week came to a head on Monday. It looked for a time as if a very healthy panic was in store for Wall Street. Subsequent events have demonstrated that it was largely made up of a scare, and that its remaining element was based upon heavy gold exports. A well developed scare in Wall Street is often more potential than actual conditions. Such it proved to be in this instance. The downward movement of last week continued, being aggravated by the action of the banks in throwing out certain Industrial stocks previously taken as collateral on loans. Distillers were the chief sufferers by this action. A number of the other Industrial stocks, as well as the railway list, went off, partially in sympathy and partially because of the money scare. Conservative elements after taking their bearings concluded that there was nothing particularly ominous in the situation, that prices had reached their lowest level, and consequently began to buy. This caused a sharp rally, in which about one-third of the ground lost in week's decline was recovered. Quotations have ranged around the this rallying point up to this date; the fluctuation being in the Industrials being about two per cent. The market of the present is far from being satisfactory, possessing a very pronounced element of uncertainty. This prompts conservative brokers and the general public to remain out of it. The total gold exports up to date aggregated $4,400,000. Of this amount all but $500,000 were shipped on Tuesday. There may be shipments to morrow, although it is now considered doubtful. We have it from undisputed sources that there will be several millions go out on next Wednesday. Already $500,000 has been engaged. This movement will tend to still further weaken the situation. Money ranged all the way from 40 to 4 per cent., the closing to-night being from 6 to 7 nominal. This is particularly suggestive when we consider that the loans are for three days. Money is never loaned on Saturday, as there are no stock deliveries, while Monday is a holiday. There are various theories promulgated in explanation of our gold shipments, which may be reduced to these conclusions: The money is going to pay our debts. These have been created by the balance of trade which is in favor of Europe. An additional and very potent cause is the continued and persistent action of European holders in unloading our securities because of their distrust of our silver situation. The market of the coming week, unless all signs are at fault, will be one of indifference and lassitude. Commission houses, pending a termination of the unsettled condition of affairs, are disparaging speculation by all except the strongest class of customers. During the latter part of the week this stock stood up remarkably well considering the general downward tendency of the list. On Tuesday it sold at 92⅞ for cash, and later in the day at 91¾ ex-dividend. During the same day it regained the ground lost and more, closing at 93. It ranged between 92 and 93 during the entire week. None but investment buyers evince a disposition to deal in the stock. Professional traders generally regard it as high. Notwithstanding, they are mindful of the lesson taught them two weeks ago when it advanced from 85 to 97. A small lot of the collateral trust five per cent. bonds sold at 106—the quotation of last week.

NEW YORK ELECTRICAL MARKET.

The conditions which ruled in the general financial world, as set fort in the preceding, were the controlling influences in this list of specialties. We find the same active inquiry for the high priced telegraph stock noted during the past two weeks. There was some weakness in Commercial Cable, although there were no transactions. It has risen steadily during the past year without hardly a set back, selling as high as 178 and being held at 180. This week it was bid 171 and offered at 175. American District Telegraph received one sale at 56½, against the highest quotation of 59 last week. American Telegraph & Cable showed a weakness in sympathy of the general situation, ranging between 85 and 86 on limited transactions. With monetary conditions restored, it is believed that this stock will score something of an advance.

Westinghouse.—Advices from Pittsburgh are to the effect that this company is overrun with orders and inquiries for its new incandescent lamp. Steps to meet this demand are being taken, and shipments will commence shortly after Jan. 1. By a new device 200 lamps can be pumped at one time. The capacity of each piece of apparatus is 4,000 lamps per day. The company intends to establish in all large cities stations for the renewal of burners in order to avoid expense of shipment and breakage. This will still further reduce the cost of the lamp. The company denies the report that it has turned over to the General Electric Company the contract for lighting at the World's Fair, or that it ever negotiated such a step.

The Copper Market.—Lake copper is strongly held at 12½c. Consumers are bidding 12.20c. quite freely. Transactions are limited in amount—the lull in business being directly attributed to the "stock taking," almost universal at this season of the year. We are informed upon good authority that there is a likelihood the copper wire pool, which has been totally demoralized for six months, will be reorganized after Jan. 1. The present actual selling price of copper wire is 13½c. The discounts have been increased to 35 and 40c. The first action of the combination will be to reduce these, and thereby put up the price.

General Electric.—This security held its own remarkably well considering the weakness of the market. At no time did it sell below 100¾, and when the rally came it quickly reacted to 12⅛. It was weaker to-day through lack of supporting orders, ranging around 110. After conditions become settled we regard it as a buy at even higher prices. A few round lots of its 5 per cent. debenture bonds sold between 99½ and 100. The United States Circuit Court has made permanent the temporary injunction recently sustained by the U. S. Court of Appeals, sustaining the Sawyer-Man Co. from using the Edison incandescent lamp.

Edison Electric Illuminating.—This stock was the strongest on the electrical list, and shows the faith of its owners in their property. On Monday, the day of demoralization, it was not traded in, owners not caring to unloaded and speculators not daring to sell short. Since that time the advance has been rapid. The closing was at 113, the highest point yet reached. Its first five bonds sold in considerable quantities a 109¾ to 110.

Brooklyn Trolley Cases Sustained.—The Court of Appeals has confirmed the order of the General Term, which held at the proceedings of the so called Rapid Transit Act of 1875, by the appointment of commissioners and the confirmation of the report of the commissioners in favor of the construction and operation of the Atlantic Avenue Railroad Company, of Brooklyn were legal. The appeal was made by the property owners along the proposed route,

Western Union.—This stock was not as greatly affected by the slump in the industrials and tight money as was predicted. Its decline is said, on good authority, to have been due by a bear influence. The price was run down about one per cent. on a sale of 2,500 shares. Almost immediately the quotation went back to 93 on about the same amount of stock it had taken to put the price down. This was during Monday forenoon. Later in the day heavy traders bid one-quarter per cent. above the market for thousand share lots without obtaining any. These orders were supposed to have been an effort to cover.

The Mexican Telegraph Company.—The directors of this company met on Tuesday at 37 Wall street and declared the quarterly dividend of 2½ per cent., payable Jan. 17. The surplus over the October dividend was $285,539; earnings for last quarter, $91,292; operating expenses, $17,500; income from investments, $7,253; current dividend, $47,815; surplus for the quarter to Dec. 31. $33,231; repairs, $4,094; estimated net surplus Dec. 31. $314,675. The earnings are at the rate of 16 per cent. on its capital of $2,000,000.

Central & South American Telegraph Company.—The directors of this company met Tuesday at 37 Wall street and declared the usual quarterly dividend of 1¼ per cent. The surplus on Oct. 31 was $295,886; gross earnings for the quarter to Dec. 31, partly estimated, $232,734; operating expenses, $72,000; net earnings, $160,734; dividend payable Jan. 10 $110,390; surplus for the quarter, $50,344; total surplus Dec. 31. $346,230, after paying January dividend. The present net revenues of the company are equal to more than 8 per cent. annum on the capital of $8,000,000, including the recently authorized increase of $1,500,000, already paid in for the duplicate cable now being shipped from London. Stockholders will meet Jan. 18 and take action to increase the capital stock from $6,500,000 to $8,000,000. The issue will consist of 15,000 shares of a par value of $100. We understand that this money is to go towards defraying the expenses of duplicating a section of the company's cable.

The Equitable Gas and Electric Company, of Utica, N. Y., has declared a dividend of 1¼ per cent., payable Jan. 16.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Dec. 23, 1892, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American District Tel....	100	3,825,000	....	....	59	59½
American Tel. & Cable..	100	14,000,000	85	86	84½	86½
Central & So. Am. Tel....	100	6,000,000	....	....	105	115
Commercial Cables.....	100	7,716,000	....	....	171	175
Gold Stock & Tel.....	100	5,000,000	....	....	100	103
Bonds.....	500	500,000	....	....	100	....
Mexican Telegraph.....	....	.....	....	....	175	190
Northwestern Telegraph.		.....	....	....	102	....
Postal Tel. & Cable.....	...	10,000,000	....	....	62	64
Southern & Atlantic Tel..	25	948,775	....	....	78	84
Western Union Tel.....	100	96,199,852	91⅜	93¾	92½	93⅝
Real estate bonds.....	1,000	1,219,000	....	....	....	..
Debenture bonds.....	1,000	4,920,000	....	....	....	..
Collateral Trust 5's....	1,000	8,181,000	106	106	....	..
North American.....	100	39,767,200	10	10½	10⅜	10¾
Brush Ill. Co. of N. J.....	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y.,....	100	6,500,000	111	113	112	113
" " 1sts.....	...	.....	109¾	110	...	..
" " Deb's....	...	.....	....	....	...	....
Edison El. Il. of Brooklyn.	100	1,500,000	...	....	106	108
" " " " Chicago..	100	750,000	....	....	130	145
" " " " Boston...	...	.....	....	....	115	125
Edison El. Lt. Europe....1,000		2,000,000	....	....	2	6
" Bonds....	....	30,000	....	....	65	80
Edison Ore Milling Co....	...	2,000,000	....	....	15	20
East River El. Light.....	100	1,000,000	....	....	....	65
General Electric	1,000	50,000,000	109½	112	110¼	111
Debenture 5's	....	10,006,000	99½	100	....	....
Automatic Exhibition Co. ...		2,500,000	..	....	3	5
Mt. Morris Electric.....	...	500,000	....	....	....	65
N. E. Phonograph.....	..	2,000,000	....	....	2	4
N. Y. Phonograph	...	2,000,000	....	....	2	5
N. American Phonograph ..		2,000,000	....	....	4	6
Westinghouse E. & M. Co. 1st p. 7 per cent., Cum.	50	3,717,253	....	....	....	....
E. & M. Co. Assg.....	50	5,038,116	....	....	....	....

BOSTON, Dec. 24, 1892.

The General Market.—During this week have come and gone the shortest days of the year, and for the majority of traders on the street, the days have been very "short" in more ways than one. The unsteady and vascillating conditions have continued in the market, and fluctuations have been very large in all the prominent stocks. The near appearance of the holidays has rendered the natural interest in the market rather luke-warm, and outside matters have proven more attractive. Tight money continues, though not at such alarmingly high figures as ruled in New York, however, quite sufficient to lead those who have funds to hold them. Gold exportation still remains an important and disintegrating influence, giving the bears a cause with which to continue hammering the prices. Days of decided strength have alternated with very weak and unsettled ones; and the sum total for the week is no improvement on the previous week. The rate for money between banks has been as high as 8 per cent, but the prevailing rates for street loans are the usual 5 and 6 per cent.

General Electric has lost still more from its price of a week ago, but one need not look for any special reason for its fluctuation, other than the raiding that all the industrial stocks have been subjected to. The usual weekly report of consolidation with the Westinghouse company is given out, originating this time in Chicago, but as usual it lacks the necessary seal of authority. Westinghouse has also succumbed to the raiding tendency that has been abroad in the street, and was freely sold down, principally because the report gained credence that the "pool" is weakening, and that a large block of stock is overhanging the market. There is little or no real probability of this, however, and it is as much of a fiction as most of the ruses that the bears use against a stock. The net earnings for the first year since the reorganization are placed at $1,000,000; and dividends are looked for on the common stock soon. The lower the stock goes, no doubt, the better purchase it becomes.

The underwriters of the General Electric bonds got about 70 per cent. of the $6,000,000 issued, at 1 per cent. commission. The price hangs very near to par all the time, with few sales.

The Great Falls Electric Light and Power Company, of Montana, with capital of 6,000 shares at $25 par value, will pay its regular semi-annual dividend of 4 per cent. Jan. 1. This is a Boston corporation, and most of the stock is held in State street. It has proved a good property and given always a good return.

The Metropolitan Telephone and Telegraph Company of New York will retire $10,000 of its bonds, through the Mercantile Trust Company, Jan. 3, at a price satisfactory to the company, and not exceeding par and 10 per cent. premium.

The West End Street Railway Company of Boston has taken up about $850,000 of the floating debt, with the proceeds of the recent sales of 6 per cent. coupon notes. The stock sales of the week show a loss of about two points, and from the buying it is known that insiders have taken what stock was in the market, and its support is good.

Street Railways in Chicago.—The value and condition of the street railway companies in Chicago are assuming tremendous proportions, and calling forth considerable speculation as to the wisdom of the policy pursued there in increasing the capital stock of the different companies and also issuing new bonds. It is evident that the experience of the Philadelphia street railroads during the Centennial Exposition is to be paralleled in Chicago during the next year, and the companies are all preparing to take care of the traffic by increasing their means of getting funds, as well as an increase in facilities for traffic. The South Side Rapid Transit Company will hold a meeting in February to authorize the issue of $5,000,000 new bonds. The entire amount of securities issued and to be issued by the companies have reached a point that is startling, when carefully considered. The bond issues, including the stock of leased companies, on which dividends are guaranteed, of the City railway, North Chicago and South Chicago street railway companies now amount to $28,133,600. The capital stock of the three companies, according to present market quotations, aggregates $66,750,000—making a total of $94,883,000—for the securities of these companies. Adding securities of outlying companies and the total becomes $98,000,000. The city company proposes to add $2,000,000 in stock in January, and the North and West Side will make additions of $1,000,000 and $2,000,000 respectively. The South Side Rapid Transit Company already has $15,000,000 of stock and bonds, and intends issuing $5,000, 00 more bonds. The Metropolitan Company has issued $10,000,000 stock and $10,000,000 bonds; and the Lake Street Company has authorized $5,000,000 stock and $5,000,000 bonds. This gives a total of $50,000,000 for the elevated roads, and makes a grand total of capitalization of intermural companies, excluding all steam and surface roads, of $153 000,000, or an average of about $122 for every inhabitant of the city of Chicago. To pay five per cent. the net earnings of these companies would have to be $7,650,000 or gross receipts of between $19,000,000 and $20,000,000 to pay a fair rate on this capitalization, as it is at present valued on the market This requires a phenomenal growth in the city to keep pace with it, and it is a matter of considerable interest and speculation as to the wisdom of such large issues as have recently been made, and those planned for the near future. This showing cannot be equaled by any city in the country under similar conditions, and it presents a problem as to whether or not the properties are not over-valued and over capitalized, above their earning capacity and natural resources for growth.

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.—Series Co...	sh	40,000	....	....	8¼	9
Thomson-Houston Elec.—Series D.....	sh	120,000	7⅞	7¾	7⅞	8
Thomson Elec. Weld..	100	1,000,000	....	....	....	....
Thomson European Elec. Weld.....	100	1,500,000	....	....	10	....
Westinghouse Elec.—New Com.....	..	6,000,000	33	30	32¼	32¾
Westinghouse Elec.—Pfd.	..	4,000,000	*49	47	47	48
General Electric.....	..	30,067,200	112⅛	109¾	111	111⅛
" " Pfd... ...		4,136,300	112⅛		112	112½
Fort Wayne Elec.....	25	4,000,000	13	12¾	12⅝	13
Fort Wayne Elec.—Ser. A.	sh	80,000	8	....	7¾	8
Detroit Elec.....	20	750,000	...	....	4½	5
West End St. Ry. Co.—Com	50	7,150,000	70¼	68	69¾	70
West End St. Ry. Co.—Pfd	50	6,400,000	85	84¾	....	84⅝
American Bell Tel	100	15,000,000	209½	208	208½	210
Erie Tel. & Tel. Co.....	..	4,800,000	50	....	49	49½
Mexican Tel. Co.....	10	1,280,000	85c.	....	85c.	1.00
New Eng. Tel. & Tel. Co..	..	10,304,600	59	58¼	59	59½
Tropical Tel. Co.....	10	400,000	....	....	....	....

*Ex. dividend.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stocks furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago	....	214	Chicago Arc Light & Power Co.....	106	106½
Central Union	56	57½	Chicago Edison Co ..	170	....

NEW INCORPORATIONS.

The Marshfield Electric and Gas Company, Portland, Ore., capital stock $40,000, has been formed to furnish light, heat and power. The organizers are S. Z. Mitchell, J. A. Cronston and O. F. Paxton, all of Portland.

The Nevada Light Company, Kansas City, Mo., has been formed with a capital stock of $100,000, to furnish electricity and gas to that city. A. E. Stilwell, W. S. Taylor, A. A. Mosher and G. L. Farrell are the organizers.

The West End Electric Company, Pittsburgh, Pa., capital stock $5,000, has been incorporated to furnish electricity for light, heat and power. A. C. Robertson, Evan Jones and W. C. Gandelfinger are the promoters.

The Citizens' Electrical Railway Company, Corning, N. Y., capital stock $100,000, has been formed to build an electric railway. Frank B. Brown, Edward Clisdell and Chas. A. Hungerford, all of Corning, are the incorporators.

The Ellwood Electric Light Company, Ellwood City, Pa., capital stock $1,000, has been formed to supply light, heat and power by electricity. H. W. Hartman, Sam. A. Rielops, and Thos. H Brady, all of Ellwood, are the incorporators.

The Canisteo Electric Company, Canisteo, N. Y., capital stock $10,000, has been formed for producing electricity for light, heat and power purposes. The organizers are Wm. T. Bailey, Levi S. Davis and Wm. G. Porter, all of Canisteo, N. Y.

The McEntee Electric Company, Chicago, Ill., capital stock $10,000, has been formed to construct and equip electric plants and to deal in electrical appliances of all kinds. Wm. Pettis, Chas. Aldworth, and Jas. A. McEntee are the organizers.

The Philadelphia, Castle Rock & West Chester Railway Company, Philadelphia, Pa., has been organized to construct and operate an electric railway. Chas. S. Hinchman, Wm. C. Olderson, and Rodman Wister are the promoters.

Morse Light, Heat and Power Supply Company, Chicago, Ill., capital stock $1,000,000, has been formed to produce and sell electricity for various purposes, etc. Geo. L. Cragg, Louis Spahar and Geo. W. McMahon are the incorporators.

The Dillon General Electric Company, Dillon, Mont., capital stock $40,000, has been formed to generate and furnish electricity for light, heat and power purposes. Earl P. Wetmore, Chas. H. Alexander and Josiah Rowden, Dillon, are the promoters.

The Altoona & Logan Valley Electric Railway Company, of Altoona, Pa., capital stock $175,000, has been formed to construct and operate an electric street railway. Cornelius Campbell, M. H. Canan and M. H. Mackey are the incorporators.

The Bradbury Stone Electric Storage Company, Portland, Me., capital stock $1,000.000, has been incorporated to manufacture and deal in electric batteries. E. W. Lovejoy, Freeman W. Puffer, Orrin B. Raulette, all of Lovell, Mass., are the promoters.

The Boyertown Light, Heat and Power Company, Boyertown, Pa., capital stock $1,000, has been started to supply light, heat and power. The incorporators are Mahlon G. Taylor, Pottstown; Thos. J. B. Rhoads and Chas. B. Spatz, both of Boyertown.

The Rochester Engineering Company, Rochester, N. Y., capital stock $100,000, has been formed to erect electric and other

railways, etc. Wm. Harrison Baily, Samuel Blodgett, Wm. Colt Albertson, Henry M. Goodhue and Edwin B. Fiske are the incorporators.

The Marietta & Maytown Electric Street Railway Company, Marietta, Pa., has been organized with a capital stock of $24,000 to construct and operate a street railway in that town. Jas. Duffy, D. B. Case and Barr Spangler, Marietta, are the parties interested.

The Goodwin Pottery Company, East Liverpool, O. capital stock $300,000, has been formed to manufacture and deal in electricity for various purposes, etc. J. H. Goodwin, G. S. Goodwin, H. S. Goodwin, Mary E. Goodwin and Viola Goodwin are the promoters.

The Luzerne Heat and Power Company, Luzerne, Pa., capital stock $2,000, has been organized to supply heat and power by means of electricity to Luzerne. Thos. R. Phillips and Chas. W. Haddock, Kingston, Pa., and Richard Clarke, of Luzerne, are the parties interested.

The Modesto Electric Light Company, San Francisco, Cal., capital stock $50,000, has been incorporated to operate electric machinery for all purposes. F. W. Eaton, Geo. E. Whitaker, Mac Caspari, H. C. Wyman, R. Lloyd Eaton, all of San Francisco, are the parties interested.

The Lebanon Valley Traction Company, Lebanon, Pa., has been incorporated with a capital stock of $10,000, to construct and operate motors, cables, etc., for supplying motor power for railways, etc. The promoters are Lyman Nutting, J. M. Shenk and Adolphus Reinoehl.

Keithsburg Electric Light and Power Company, Peoria, Ill., capital stock $15,000, has been formed to furnish an electric light and power plant in Keithsburg, and to buy and sell electrical apparatus. The promoters are E. B. Hillman, L. B. Bradley and H. T. Hays.

The Farmington Electric Light and Power Company, Peoria, Ill., capital stock, $12,000, has been organized to erect an electric light and power plant in Farmington, and to deal in electrical apparatus, etc. E. B. Hillman, L. B. Bradley and H. T. Hays are the incorporators.

AFFAIRS OF THE COMPANIES.

The Industrial Improvement Company has purchased the Merrimac Valley Street Railway Company.

The Elkton, Md., Electric Light and Power Company has decided to increase its capital stock as authorized by its charter.

The Peoples and Consolidated Railway Companies, comprising all the street railways in Syracuse, N. Y., have been sold to a syndicate which will operate the road under one management, the capital stock of the company aggregates about $2,500,000. The syndicate consists of six capitalists of New York, Cincinnati and Cleveland. The system will be equipped with electricity.

The Lynn & Boston Street Railway Company has petitioned the commissioners for right to increase the capital stock by $1,000,000. The increase is necessary to provide funds to pay for the Essex, Lynn Belt Line, and Naumkeag of Salem, companies, which have recently been purchased. The North Shore Traction Company already has $6,000,000 capital, and controlls all these properties, and now more stock is wanted. The plan is that of a wheel within a wheel, each doing its work.

The W. D. Graves Electric and Manufacturing Company, Cleveland, O., has increased its capital from $25,000 to $75,000, and is now looking for a larger work shop, although it has lately trebled its capacity. The new Graves arc lamp for high or low tension currents is giving satisfaction even with six or eight on street railway circuits. It is brilliant and simple in construction, with small cost for maintenance. This company is now shipping them in all directions on first and duplicate orders.

The Bell Telephone Output.—The instrument output of Bell Telephone Company for the month ended Dec. 20, and for the fiscal year to that date is reported as follows:

Month ending Dec. 20:	1892.	1891.	Inc.
Gross output	6,770	5,095	1,675
Returned	4,056	3,522	534
Net	2,714	1,573	1,141
For fiscal year to Dec. 20:	**1891-92.**	**1890 91.**	**Inc.**
Gross	93,579	69,452	24,127
Returned	54,247	42,762	11,485
Net	39,332	26,690	13,642

Formation of a New Company.—A meeting of Baltimore capitalists and others interested in the Maryland Electric Company was held at the office of that company last week. It was decided to form a new company from the Maryland Electric Company, and increase its capital stock from $500,000 to $2,000,000. The new company will make plans to furnish light, heat and power, and will probably build a station having a capacity of from 6,000 to 7,000 h. p. They also have the exclusive right to use the Edison system of lighting, and will run all wires under ground. Among those present at the meeting were Messrs. R. T. McDonald, president of the Fort Wayne Company, Indiana; J. Preston Hix, representative of the Edison Company, New York, and J. Frank Morrison, manager of the Maryland Electric Company, and the probable general manager of the new company.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Dec. 24, 1892.

Mr. William Wright has resigned from the Wright Universal Electric Company, of 26 Whitehall street, New York City.

Mr. James Pembroke, late director of the Manhattan Electric Supply Company, of New York City, has severed his connection with that company, and will shortly open a new electrical supply house on his own account in this city.

Mr. Jean A. Wetmore, who has just returned from a trip through the West in behalf of the Okonite Company (Limited), says that the Okonite insulated wires and cables are carrying everything before them in that section of the country. At the New York headquarters of the company, 13 Park Row, business is reported as excellent, and 1892 will close a very busy year.

Rapid Transit of Mails Between New York and Brooklyn.—The Postmaster-General has, it is reported, entered into an agreement with the United States Automatic Despatch Company of New York by which the company agrees to lay at its own expense a double line of tubes connecting the main post-office building in New York with the main post-office at Brooklyn for the transmission of the mails. It agrees to pay all expenses connected with the construction of the system, to maintain and operate it for a year, to remove it when required to do so by the Postmaster-General, and to pay all damages to the buildings or other property. When completed the company agrees to turn over the tubes and their appurtenances to the Post Office Department for such practical tests as the postmasters at New York and Brooklyn or the Postmaster-General may see fit to make, the tests to be at the expense of the company. It is further agreed that the company shall provide electric power for the operation of the system, and shall lease it to the United States year by year, or sell it to the United States at actual cost. Application will be made to the Bridge Trustees for permission to place the tube on the bridge and the work of construction is to be begun at once.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Dec. 24, 1892.

The Newburyport Gas and Electric Company received yesterday a new 50-arc light dynamo from the Thomson-Houston company to meet the increasing demand for electric lighting in that city.

Moseley & Co., manufacturers of hosiery and mittens at Needham, Mass., have put an electric light plant into their factory. This is the first thing of the kind in that town, and they report it a great improvement over kerosene oil.

The New York Insulated Wire Company has opened a branch office at 182 Sumner street, this city, with Mr. W. S. Barker as agent. This company are makers of the celebrated Grimshaw wire and tape, have branch offices in nearly all the large cities, and the branch in Boston is sure to succeed under the management of Mr. Barker.

The Elektron Manufacturing Company, of Springfield, Mass., has just finished a motor to work in connection with the A. B. See elevator. Its first passenger elevator has just been placed in the large dry goods establishment, of Smith & Murray, of Springfield, and has stood the test of the immense crowds of holiday shoppers exceedingly well.

The East Side Association of Melrose will hold a meeting at the Upham street school house next Thursday evening to arrange for an electric railway in the eastern section of Melrose. It is desired that the railroad should extend from the Highlands either through Green or Porter street to East street, and thence southerly to Swains Pond avenue.

A New By-Pass Valve.—The Mason Regulator Company, of Boston, Mass, some time ago manufactured a new by-pass valve for use on electric elevator pumps. This is designed to open the water pipe when the tank pressure rises above the normal, and close it again automatically, when the pressure drops, so that the pump may keep working all the time, if necessary. It is very sensitive and positive. A large number are already in use by leading elevator people.

The Campbell Electrical Supply Company, 104 High street, Boston, Mass., has just issued a new catalogue of its "Century" wires and products, having cancelled a contract with its agents for the manufacture of the celebrated "T. Z. R." wire. This company is now prepared to furnish its goods at first hands; made after the original formulas of the "T. Z. R." Insulation, with important improvements recently made by the original inventor, Mr. Henry F. Campbell.

Since the Eddy Electric Manufacturing Company placed its Boston Agency in the hands of Mr. D. P. Gosline, of 30 Oliver street, excellent results can be shown. Mr. Gosline now has two very efficient salesmen who are pulling in the business, but Mr. Gosline has the credit of certainly possessing first class practical qualifications in this line of trade. Motors made by the company can be seen in operation at the salesroom.

Rockport, Mass.—The meeting held this week in the interest of establishing an electric railway between Rockport and Pigeon Cove was largely attended by capitalists and sufficient stock subscribed to warrant the forming of a company. It is the purpose of the prime movers to push the matter. The route will probably be from Pigeon Cove Post-office to Dock Square, passing the Boston & Maine station. It will be constructed for passenger and freight traffic, accommodating the granite companies along the route.

PITTSBURGH NOTES.

The Pittsburgh Electric Club will shortly commence a series of lectures at the club rooms. Dr. Wellington Adams of St. Louis-Chicago Electric Railway fame is booked as one of the first to entertain the members of the club with an informal lecture.

The McKeesport Electric Light Company was reorganized at a recent meeting, and the following officers elected: President, James S. Kuhn: secretary and treasurer, Homer C. Stewart; directors, E. C. Converse, W. E. Harrison, Horace Crosby, James S. Kuhn, John A. O'Neil and W. A. Dunshee. The works will be enlarged.

The project for the extension of the Sharpsburg branch of the Citizens traction line to Aspinwall is to be carried out at last. Work on the extension will be begun immedialely. A force of 100 men has been employed, and the officials of the company say that they will have cars running by Jan. 15. It is said that the Aspinwall Land Company gave the company a bonus of $5,000 for the extension.

The Duquesne Traction Company, one of the largest electric street railways in Western Pennsylvania, has just issued its annual report. During the year 5,417,348 passengers were carried and the total receipts from passengers were $283,399.35. For maintaining the road or real estate of the corporation and operating the road $257,878.32 were expended, and in interest $51,450. The entire amount of capital stock ($3,000,000) has been paid in. There is no record of any dividends having been paid. Four persons were injured during the year.

WASHINGTON NOTES.

WASHINGTON, D. C., Dec. 17, 1892.

The Brightwood Electric Railway Company will build a branch from its present line to Zoological Park. The overhead trolley system will be used.

The District of Columbia Suburban Railway Company has completed the survey for its line, and grading for the country portion of the road will commence in about two weeks time.

The Mount Vernon Electric Railway Company will add two passenger and one freight car to its present equipment. Mr. L. W. Spear formerly secretary and treasurer, and also a director of the company, has resigned.

The Metropolitan Street Railway Company has for several months been experimenting with a new kind of storage battery with a view to its adoption if proved successful. It is now reported that the line will be operated by this system on and after Dec. 20, and all horses withdrawn.

The route of the East End Electric Railway in a hearing recently held before the Commissioners of the District was changes, as proposed by Senate Bill 3,524, were made in accordance with the suggestions of parties opposed to the original route. Work upon the line will soon be commenced.

The House bill granting the Eckington & Soldier's Home Railway Company, two years time in which to remove their trolley wires on New York avenue, has been reported favorably with an amendment allowing the company to extend its tracks to Thirteenth street, east, and to occupy Thirteenth street, between "C" and "D" streets.

The Wheless Underground Conduit System is being installed upon the Arlington Railway, and as soon as completed it is said the question of extending a branch of the road to Falls Church, Va., and another to Alexandria, Va., will be seriously considered. Petitions are being circulated through the county asking Congress to allow the cars to cross the river on the piers of the acqueduct bridge.

The directors of the Burnt Mills & Sandy Springs Railroad Company recently held a meeting and it was stated that arrangements had been made for the survey of the proposed new railroad, which will start from the bounds of the city at the head of New York avenue, and go by way of Riggs Mills and Burnt Mills to Sandy Springs, Montgomery County, Md. The capital of the company is $200,000, and it is expected that the work of construction will be begun as soon as the survey has been completed. Dr. Stone is the president and Mr. Geo. W. Cissel is the treasurer of the company.

Mr. Gilbert Moyers, president of the District of Columbia Suburban Railway Company, recently appeared before the Commissioners to talk over the details of the permit for the construction of the road, there having been some difficulty due to a peculiar wording of the charter. The permit as issued provides for a double track on the Bladensburg road from the Boundary line on "H" street northeast. It also provides for tracks on Twelfth street northeast on Mount Olivet road, on Capitol and Corcoran streets, Ivy City and Twelfth street (extended), Brookland. Iron trolley poles will be used on Bladensburg road as far as Mount Olivet road and on Twelfth street & Mount Olivet road.

A bill has been introduced to incorporate the Washington & Marlboro Electric Railway. The incorporators are James G. Berret, Chas. E. Creecy, Wm. E. Hill, George J. Johnson, John A. Luttrell, R. A. Howard, Chas. C. Lancaster, James T. Perkins, A. M. Bliss and J. W. Belt. They are authorized to lay a single or double track railway from the corner of Eighth street and Pennsylvania avenue S. E. to the District line by way of Pennsylvania avenue, Bowen rd. and Branch avenue. At the District line the road will connect with the Prince Georges Co., (Md.) branch of the same line. Two years are given in which to complete the line. The capital stock is $250,000, in shares of $100 each.

The Rock Creek Railway.—Work upon the "U" street extension of the Rock Creek Railway, upon which the Love Electric Conduit system will be installed, was commenced on Dec. 5, and is being pushed with as much haste as possible. About one mile of double track road will be operated under this system and it is expected that cars will be running shortly after the first of the new year. This construction is being watched with considerable interest by street railway men in this city who have yet to change their motive power, in compliance with laws lately enacted, as they are anxious to secure an electric system of the storage or underground type which is an assured success from a commercial point of view the law forbids the use of the trolley within the city limits.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Dec. 24, 1892.

Mr. D. W. Davis, formerly salesman and superintendent of Buckeye Engine Company has taken charge, as manager, of the Western branch office of the Phœnix Iron Works Company, of Meadville, Pa., manufacturers of automatic simple, compound and triple-expansion engines, boilers, etc. Mr. Davis is located at 418 Chamber of Commerce Building.

The Electric Appliance Company is placing on the market a ceiling rosette in the line of an improvement on the Shaefer cut-out with a removable cap. The cap is attached without screws by a quarter turn to the right and detached by a similar turn in the opposite direction. To prevent the possibility of the cap jarring loose, which has been the great difficulty in other cut-outs of this style, a supplementary phosphor bronze spring has been added, making loosening almost an impossibility. The cut-out is placed on the market under the name of Acme Ceiling Cut-Out.

The Chicago Lake View & Suburban Electric Railroad Company is the name of a new organization that has, within a short time, been given authority to incorporate in this city. One of the gentlemen interested says that so far as decided at present the road will start from Waukegan and take in Winnetka, Evanston, Ravenswood, Rogers Park and Lake View, thence connecting with cable lines on the North side and eventually will come into the city as an elevated road. The latter, however, is a question of the future. Waukegan is thirty-five miles north of Chicago and some of the towns mentioned are not on a direct line. This part of the city is growing rapidly, and is badly in need of rapid transit, so that this enterprise, whether a legitimate one or not, has in it some of the elements of success.

The Cedar Rapids (Iowa) Electric Light Company met with a serious accident on a recent night. A fine new engine was being tested for the first time when, for some reason unexplained, the governor belt parted, and before steam could be shut off the fly wheel was revolving at such speed that in an instant the metal gave way and immense pieces, one or two weighing several hundred pounds each, were thrown off at a tangent, scattering roof timbers, partitions and parts of the machinery in every direction. Fragments of the wheel cut the arc light wires, leaving the city in instant darkness, and still another one struck a new dynamo and practically ruined it. Two engineers were in the room, but neither were injured. A large addition to the plant was being installed, the electrical and mechanical engineers having some little work yet to do. The loss is estimated at fully $4,000.

TACOMA, Dec. 20.

Mr. L. H. Griffith, general manager of the Tacoma Railway and Motor Company, has returned from an eastern business trip.

Mr. H. M. Byllesby, of St. Paul, president of the Northwest General Electric Company, recently visited Puget Sound on business.

Mr. A. L. Hawley, General Manager of the Union Electric Company, of Seattle, has gone to Chicago on a business trip in the interest of his company.

The Light, Heat and Power Syndicate, of Tacoma, has completed and put into operation a new underground conduit and tunnel connecting the various buildings lighted and heated by its system.

The Northwest General Electric Company has installed a 650 light Thomson-Houston incandescent plant at the Puget Sound Wire Nail Works in Everett, Wash. Three hundred of the lights will be used in a hotel and the remainder on the streets.

The City and Suburban Railway Company, of Portland, Ore., is securing the right of way for a double track to East Thirty-third street. When this has been accomplished the track will be laid at once. A 10-minute service will be given as far as Sunnyside.

The Tacoma Railway and Motor Company has just put into operation two additional railway generators of 175 kw. capacity each. They were installed by the Northwest General Electric Company and are of the standard Edison type. The company now has six of these machines in its station.

The Shoshone Falls of the Snake River in Idaho, which have a body of water 900 feet in width and a fall of 210 feet, are likely to be used to supply electric power for irrigation. A large number of water wheels are expected to be put in and pumping stations operated by electric motors will be erected at suitable points. The water will be elevated to canals through which it will be conveyed to the adjacent villages.

The Portland (Ore.) Consolidated Railway Company, G. B. Markle, president, has asked for a franchise on a number of streets on both sides of the river in order to straighten out and complete its lines. They wish to cross the Burnside street bridge, and build a road out to the new race track. The cost of the proposed lines complete is about $250,000. Union avenue would be occupied its entire length.

L. F. Cook's electric railway system was given a trial in Tacoma recently. A 10 per cent. grade was successfully overcome on an elevated structure having curves of 70 feet radius, and a speed of 25 miles per hour is claimed by the inventor, who is satisfied with his test. The single car operated is 13 feet long, accommodating eight passengers and is propelled by a 15-h. p. Edison street railway motor. A bevel friction wheel 15 inches in diameter converts the tractive power.

News of the Week.

THE TELEPHONE.

Industry, Ill., will shortly be connected by telephone with Macomb.

A long distance telephone line between St. Louis and Kansas City is under discussion.

A Long Distance Telephone Line between Minneapolis and Chicago has been considerably discussed within the past few weeks; but the conclusion reached was that it would not be a paying investment; cost is $30,000 for line construction with a depreciation of over $10,000 per year and the cost of $4,200 for operating expenses, repairs, etc. This would make a total cost per year of $15,000, and it is not thought that there would be sufficient business to warrant the construction of such a line.

THE ELECTRIC LIGHT.

West Union, Ia., is making efforts to secure an electric light plant, and will probably be successful.

Washoe, Ill., is now lighted by electricity, the new plant having been completed and put in successful operation.

Columbus, Ga.—A number of Northern capitalists recently visited Columbus for the purpose of investigating the conditions and advantages of that place for the erection of an extensive electric plant.

The National Electric Light Association.—At the next meeting of this Association, which is to be held in St. Louis, Mo., Feb. 28, March 1 and 2, 1893, there will be no exhibit under the auspices of the Association.

The smallest electric light installation in the world is perhaps that in the little village of Bremen, near Dormbach, in Thuringia. It comprises a single arc lamp, installed in the church, the lamp being operated when required by a small dynamo placed in the village mill and driven by the mill wheel.

Wellesley, Mass.—The new electric light plant was put in operation for the first time last week. The system is made up wholly of 25 c. p. incandescent lamps, placed at a distance of from 125 to 250 feet apart. The plant is one of the best in New England, equipped with Westinghouse apparatus, and furnishing 400 lights. The town owns its street plant and purchases its current.

To Bury the Electric Light Wires of Cincinnati.—Corporation Counsel Horstmann rendered an opinion today to the effect that the city has the right to order all electric light wires under ground. The city engineer's department is drafting an ordinance for a subway to be finished early in 1893. It will not be many months before the wires in the main body of the city will be under ground.

Cleveland, O.—A stock company has been organized which proposes to light the entire city of Cleveland by electricity. It has issued bonds for $1,000,000, and will proceed to work at once. The two electric lighting companies, the Cleveland and the Brush, have been merged into it, and many of their stockholders are stockholders in the new company. Mr. James Parmelee is the secretary. The new company will be known as the Cleveland General Electric Company.

Toledo, O.—A strike has been declared of all the electric linemen in the employ of the Toledo Electric Light, Western Electric Light and Power, Toledo Electric Railway, and Consolidated Street Railway companies. They gave no warning, and the city was unaware of trouble until the lights all over the city went out and the street cars stopped. The linemen held a meeting and decided to wait until the companies granted an increase of 10 per cent in wages.

The Lighting of Philadelphia.—Contracts awarded for the electric lighting of Philadelphia show a range of from 39 to 55 cents per arc lamp per night. More than one half the lights are to be furnished at the lower rate. A few years ago the average charge was about 50 cents. The contracts call for 1,363 lights at 39 cents, 417 at 45, 238 at 47, 262 at 50 and 250 at 55 cents, the higher rates being charged on suburban lines, with relatively small service per mile of line wire.

THE ELECTRIC RAILWAY.

The Common Council, of Lockport, N. Y., has granted a franchise to the Lock City Electric Railroad Company to build and operate a line in that city seven miles in length.

American capitalists are negotiating for the street railway system of the City of Mexico and its suburbs. The lines are about 100 miles in extent and the capital is reported as $5,200,000.

A Proposition for a Belt Line.—The Central Labor Union has adopted a series of resolutions urging the City of Chicago to construct a belt line street railway which will practically encircle the city.

New Electric Lines.—An electric road is proposed to run from Newton Highlands, Mass., thence to Newton, and to Oak Square. Nearly $100,000 has already been subscribed for its construction.

Billerica, Mass.—A meeting of the citizens of Billerica was recently held in order to consider the petition of the Lowell & Suburban Street Railway for double tracks in several of the important streets of that town.

The West End Street Railway drivers, conductors and motormen have asked for an advance in wages of 25 cents per day for the coming year, and that the working time shall be kept down to 10 hours within 12 consecutive hours.

Secretary of War Elkins and William C. Whitney are, it is reported, at the head of a syndicate which is soon to obtain control of the City Railroad Company and other surface railroads in Brooklyn. It is said that $20,000,000 is available for this purpose.

Electricity Recommended as the Motive Power.—The Cleveland, O,, City Council has passed an ordinance giving the Cleveland City Cable Company authority to use electricity on all its lines. The St. Clair street line will be immediately equipped.

Woburn, Mass., capitalists are considering the feasibility of constructing an electric railway between Woburn and Lowell. If the proposed line is built, Lowell will be connected with Boston by its street railway line, and about 10 miles of the distance will be operated by the West End Company.

To Connect the Twin Cities by Electricity.—It is rumored that the Northern Pacific Railroad at a very early date will build a large depot on Broadway, St. Paul, where they can obtain a large piece of property for the general use of the road, and next year, in connection with the Edison Company and the St. Paul Gas Light Company, own and operate an electric short line between St. Paul and Minneapolis, over the Northern Pacific tracks.

PERSONALS.

Nikola Tesla has been elected a member of the Royal Institution.

Aurelio Arango, of 132 Madison avenue, New York City, the treasurer and general manager of the Edison Spanish-Colonial Electric Light Company, died yesterday afternoon of heart disease in the Chambers Street Hospital.

Dr. W. Leigh Burton, the well known dentist, died in Richmond, Va., last week. He was known in the electrical field as the inventor of the Burton electric heater, which has recently come into quite general use for heating and cooking purposes.

Mr. Whittier's Investments.—The inventory of the estate of Mr. John Greenleaf Whittier (amounting in value to $133,730) shows that the greater portion was invested in various railroad and electric stocks, and that the money was so distributed that over 100 different investments were on the list, the amounts being about the same.

The Death of Father Henrici, the leader of the Harmonists, occurred at Economy, Pa., the settlement of this society, last week. Considerable interest is manifested in the future of this community, as it is said to possess a great deal of property and its numbers are rapidly decreasing. Mr. Jacob F. Henrici, the nephew of Father Henrici, was at one time an editor of THE ELECTRICAL WORLD.

Mr. W. Forman Collins has resigned his position as Western editor and manager of the *Electrical Engineer* and has assumed the business management of the *Western Electrician*. Mr. Collins has had a wide experience in electrical journalism in the East as well as in the West, as prior to his connection with the *Electrical Engineer* he held a position on the staff of THE ELECTRICAL WORLD.

MISCELLANEOUS NOTES.

The Factory of the United States Mineral Wool Company, at Stanhope, N. J., was partially destroyed by fire on Dec. 1, and all the stock on hand was lost. The company immediately commenced to rebuild in order not to delay meeting their contracts and it is hoped it will be in running order by the latter part of the current year.

Buffalo, N. Y.—The Thomson-Houston electric light plant in Court street was badly damaged by fire on the morning of Dec. 16. The fire was caused by a defective switchboard and the most of the dynamos were totally destroyed, leaving a considerable portion of the city in darkness. The building was saved. The damage is estimated at $50,000, which is fully covered by insurance.

Mr. Frank Kitton, read a paper before the Buffalo Electrical Society Dec. 19 on the subject of Magnetism. The lecture was illustrated by numerous experiments, and proved to be a very interesting one. After the discussion seven new members were elected. The librarian reported the addition of a number of new books to the library, among which was a handsomely bound volume on Street Railway Construction presented by the J. G. Brill Company, of Philadelphia.

The Young Men's Institute of the Young Men's Christian Association of the City of New York, 222 and 224 Bowery, is giving much attention to technical studies and the work is becoming more and more valuable to young mechanics and artisans. The evening classes in electricity, steam engineering, carriage drafting, mechanical drawing, free hand drawing, shorthand and type writing, vocal music, arithmetic, bookkeeping and English grammar, have an enrollment of almost three hundred young men. A free exhibition of work done in the classes was given on Dec. 26, from 9 A. M. to 10 P. M. The Institute Committee of Management and the Carriage Builder's National Association award prizes, diplomas and certificates of progress at the close of each class year.

The Cataract Construction Company of Niagara Falls and the Cataract Electric Company of Buffalo recently held a meeting in Buffalo at which an agreement was made in reference to the transmission and sale of power. Definite notice was given that 10,000 h. p. would be transmitted to the city of Buffalo and furnished at a price less than that for power, which is generated in the city by steam. The question of the right of way was taken up and it was urged that the American side of the Niagara River be used. The Cataract Construction Company stated that it was immaterial to it whether their wires were run over the American shore or on the Canadian side, except that the property owners on the latter side had granted it the right of way free while there seemed to be considerable difficulty in securing the privilege on the former. At first two 5,000-h. p. turbines will be used and more added as they may be needed. As to the date at which power will be furnished no statement was made, except that it would not be later than next summer.

Industrial and Trade Notes.

The Knapp Electric Novelty Company, 34 Warren street New York City, is receiving large orders for its fan motors.

The Backus Water Motor Company, of Newark, N. J., of which Mr. Cissel is manager, has a new electric ceiling fan, the special feature of which is that the motor is in the base of the fan. On actual test it will have less current than any fan in the market. It runs on less than 16 c. p. This company manufactures ventilating and rotary fans.

The Keystone Electric Company, Erie, Pa., has just completed an electric motor for elevator purposes that is a success and adapted to most elevators. This company's business has increased so that that the present quarters are not large enough, and it contemplates the erection in the spring of a brick building 145 feet by 45 feet, three stories high, with a boiler house added.

The Excelsior Machine and Cleveland Punch and Shear Works, Cleveland, O., successors to Leighton & Hathaway, are very busy in all their departments manufacturing the Hathaway patent transfer tables with improved anti-friction running gears for street railways, combined punch and shears, punch and power press, post and suspension drill, power bending rolls, etc., for street railway repair shops and machine shops. A handsome catalogue will be sent on application.

The Eureka Tempered Copper Company of North East, Pa., manufacturer of tempered copper segments for commutators and other copper appliances for dynamos, motors and electrical purposes, has been exceedingly busy in keeping up with its orders, and is now extending its works, building a large brick addition two stories high, which will soon be completed. Extra boilers and machinery will also be put in. The company is now getting out some extra heavy work for the World's Fair use for the Westinghouse Electric & Manufacturing Co. and others, which will soon be ready.

The Peckham Motor Truck and Wheel Company, of 45 Broadway, is running its works at Kingston, N. Y., both day and night, manufacturing its cantilever trucks. "The Peckham" is the longest spring base truck made, and for general efficiency is said to be unequaled, and has been adopted as the standard on many of the leading electric roads. The "Dandy" track scraper, manufactured by this company, is the only scraper secured direct to the truck frame. The recent large orders for this scraper is practical proof of its superiority over the old style of fastening them to the car body.

G. d' Infreville's "Wasteless" Gravity Zinc is becoming very popular, as is evidenced by the following orders recently received, some of which are duplicates: Postal Telegraph Company, of New York, 1,800 zincs; Mexican Central Railway Company Limited, 800; Western Electric Company, 300; Long Distance Telephone Company, 200; Kings County Elevated Railway, Brooklyn, 100; Kinsman Block System Company, New York, 480; Watertown Fire Department, Watertown, N. Y., 100, and numerous other smaller orders. The letters received from parties who have used the "Wasteless" Gravity Zinc testifying to their superiority are very flattering.

The Joseph Dixon Crucible Company, of Jersey City, manufacturers of Dixon's "American Graphite" pencils, and graphite for electrical purposes, is taking time by the forelock by putting a fifth story, 175 × 75 feet, on its pencil factory. During the past summer and fall it has been unable to promptly fill orders, even though working to full capacity. The new addition will be equipped with new and improved pencil machinery of their own invention. Besides this large addition to its pencil factory, the company will establish a rubber and brass plant for the manufacture of the various pencil accessories and novelties. As it was only in 1891 when the Dixon company put extensive additions on its crucible and black lead works, and erected offices which for size and beauty are second to none in the State, it is very evident that prosperity attends the Dixon company, and that the company is well officered and wisely managed.

The Chicago Electric Wire Company, of which Mr. William Weightman, of Philadelphia, is the president, is the successor to the Cobb Vulcanite Wire Company. In the reorganization of that company it was found that new machinery throughout was necessary to carry on successfully the manufacture of insulated wire. This important work was intrusted to Mr. H. W. Cobb who has made three inventions which are of great value to the company, and which will largely increase the daily output. The first of these machines is what is called a rubber press for pressing the insululation on the wire, and has an output of about 10,000 feet per day. The second invention is an improved lead press which reduces the expenses of that part of the process considerably aside from increasing the output. The third invention is an improved method of vulcanizing the rubber wire, and the same time subjecting it to great outward pressure. By the addition of this new machinery the company's daily output is now over 40,000 feet.

The E. W. Bliss Company, Ltd., 17 Adams street, Brooklyn, N. Y., has made some very extensive improvements in its works during the past 12 months. After amalgamating its business with that of the Stiles & Parker Press Co., it was decided to move the entire plant to the Brooklyn Works. An additional building 150 feet long by 90 feet wide and six stories high was erected. The company's machine shop now occupy the entire block bounded by Adams, John, Pearl and Plymouth streets, and enclose in the centre an erecting shop for heavy machinery spanned by a 25 ton electric traveling crane. A large number of new machine tools have been put in, and some large boring and milling machines especially adapted for this sort of work are being constructed. A portion of the works has been equipped with special machinery for the manufacture of the Whitehead torpedo and torpedo guns which the company is making on contract with the U. S. Navy Department. All the departments have been well filled with orders during the past year, and the prospects for the cominy year are excellent.

The Wrought Iron Bridge Company, of Canton, O., with New York offices at 136 Liberty street, Mr. H. A. LaChicotte, manager, which has for many years been working at a disadvantage on account of its cramped quarters, has recently erected in the Southwestern part of Canton, O., where it is on the line of one railroad and is accessible by independent switch tracks to two others. The site is about 12 acres in extent, and is an ideal one for the purpose for which it is employed. The works are equipped with the very best of modern machinery, and every convenience for turning out first-class goods at a very rapid rate has been added. The distinctive feature of the plant is the operation of the machinery by electricity, and this company is the first bridge company to adopt this innovation. In the engine room are concentrated the engines, electric generator, incandescent and arc light dynamos, air compressor, receivers, and overhead the compressor are ventilating and heating fans. From the generator power is conveyed to 17 motors placed in various parts of the shop, each motor operating one, two or more machines, according to the work required. This method of distributing power is found not only to

be very convenient but economical as well. The Wrought Iron Bridge Company has recently entered the electrical field.

Ajax Switches.—During eight weeks, ending Dec. 14th, the shipments of Ajax switches have been as follows: Buffalo, Bellevue & Lancaster Railway Company, 6 generator switches, 1,200 ampère capacity; M. R. Muckle, Jr., & Co., 5 switches, 925 ampère; Edison Electric Illuminating Company, Paterson, N. J., 4 generator switches, 3,200 ampère; Alexander, Barney & Chapin, 3 switches, 800 ampère; Troy City Railway Company, 7 switches, 2,800 ampère; W. H. Gordon & Co., 1 switch, 600 ampère; Detroit Electric Works, 4 generator and 3 feeder switches, 1,700 ampère; Electrical Supply Company, 5 switches, 2,100 ampère; Robbins Electric Company, theatre switch-board, 32 switches; Newport Street Railway Company, 4 switches, 800 ampère; General Electric Company, 11 switches, 2,200 ampère; H. Ward Leonard & Co., 18 switches, 7,000 ampère; Short Electric Railway Company, 10 switches, 3,000 ampère; Rochester Railway Company, feeder switch board, 1,200 ampère (second order); Buffalo Railway Company, 10 generator and 24 feeder switchboard, 8,800 ampère; capacity of "Ajax" switches and 10,200 ampère capacity of "V. N." knife switches (third order). The demand for Ajax switches during the past five months has exceeded the output, but, with increased facilities, the manufacturers will enter upon the season of '93 determined to make better switches and more prompt deliveries.

Warren Webster & Co., 491 North Third street, Philadelphia, have issued a new catalogue describing the well known Webster vacuum and feed water heater and purifier. This company reports the following sales for the month of November: Ohio Valley Fire Clay Company, Toronto, O.; Oswego Starch Company, Oswego, N. Y.; John Francey's Sons & Co., Toronto, O.; Armour & Co., Chicago, Ill.; George W. Tapley, Springfield, Mass.; American Iron and Steel Company, Pittsburgh, Pa.; Merchant's National Bank building, Chicago, Ill.; Laidlaw & Dunn Company, Cincinnati, O.; Horlicks Food Company, Racine, Wis.; Western Coal Machinery Company, Denver, Colo.; Niles Paper Company, Niles, Mich.; National Foundry and Pipe Works, Ltd., Scottdale, Pa.; Heath & Milligan Manufacturing Company, Chicago, Ill.; Boughen Engineering Company, Cincinnati, O.; Barnhart Brothers & Spindler, Chicago, Ill.; W. F. & F. C. Sayles, Saylesville, R. I.; Kilbourn Knitting Machine Company, Martinsburg, W. Va.; Merrick Thread Company, Holyoke, Mass; Walter A. Wood Harvester Company, St. Paul, Minn.; D. Lowenburg, Norfolk, Va.; The *Standard Union*, Brooklyn, N. Y.; J. H. Sternburgh & Son, Reading, Pa., Markle Fire Clay Company, Toronto, O.; Otis Falls Pump Company, Livermore Falls, Me.; Landers, Frary & Clark, New Britain, Conn.; Frontenac Paper Company, Limerick, N. Y.; Nelson Morris & Co., Chicago, Ill.; Edward Joy, Syracuse, N. Y.; Thomson-Houston Company, Tremont, O.; National Wall Paper Company, Brooklyn, N. Y.; Sazon Worsted Company, Providence, R. I.; American Playing Card Company, Kalamazoo, Mich.; Work House, Cleveland, O.

McIntosh, Seymour & Co., of Auburn, N. Y., still continue to run 23 hours a day, as they have done for the last four years, and have orders on hand for a good many engines, of which the following are the principal ones: One 1,200 h. p. double tandem compound condensing railway engine, for the Syracuse Electric Light and Power Company, Syracuse, N. Y.; this engine has a number of novel points, including a new style frame, ball and socket self-oiling pillow block bearings, auxiliary shafts carrying the eccentrics and governor; this engine will have a wheel 7 ft. face, to carry two belts, and a shaft 16 in. in diameter; one 600-h. p., four-cylinder vertical triple expansion engine, for the Elmira Illuminating Company, Elmira, N. Y.; also two 350-h. p. tandem compound condensing railway engines for the same company; one 600-h. p. double tandem compound railway engine for the Hoboken Electric Light Company, Hoboken, N. J.; one 500-h. p. double tandem compound for the Pennsylvania Railroad, Jersey City; two 500 h. p. standard compound condensing, self-contained engines for the Citizens' General Electric Company, Louisville, Ky.; one 500-h. p. standard, compound condensing, self-contained engine for the East River Electric Light Company, New York City; one 500-h. p. standard, compound condensing, self-contained engine for the Edison Illuminating Company, New York City. (These last mentioned 500-h. p. engines are the largest and heaviest self-contained compound engines made in the country. They weigh 40 tons each. The shaft is 11 inches in diameter.) Two 400-h. p. standard, self-contained compound engines for the Halifax Illuminating and Motor Company, Halifax, N. S.; one 350-h. p. standard, self-contained compound engine for the Consolidated Electric Light and Power Company, Dover, N. H.; one 250-h. p. standard compound railway engine for the Baltimore Traction Company, Baltimore, Md.; two 250-h. p. standard compound engines for the city of Durban, South Africa; three 150-h. p. standard compound engines for Union Elektricitets-Gesellschaft, Berlin, Germany; one 75-h. p. standard compound engine for Adolph Sutro, San Francisco, Cal.; one 200-h. p. single cylinder railway engine for the Woburn Electric Light Company, Woburn, Mass.; one 200-h. p. single cylinder engine to go to Washington, D. C.; one 125-h. p. single cylinder engine for the Cooperstown Electric Company, Cooperstown, N. Y.; one 150-h. p. single cylinder railway engine for Sing Sing, N. Y.; one 100-h. p. single cylinder engine for Lexington, Mass.; one 75-h. p. direct coupled single cylinder engine for the North Chicago Street Railway Company, Chicago; three 55-h. p. single cylinder engines for the East River Gas Company, New York City, and other small engines. They are also making a 1,200-h. p. engine for the World's Fair, to be direct belted, and one direct coupled 300-h. p. railroad engine, and one 300-h. p. direct coupled alternating outfit.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filter for sale cheap; send for prices to Purity Oil Filter Manufacturing Company, 901 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

The Albany Lubricating Compound and Cup Company, 313 West street, New York City, has issued a very handsome calendar which will be sent to any engineer who will send his address and the name of the company with which he is connected.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.

UNITED STATES PATENTS ISSUED DEC. 20, 1892.

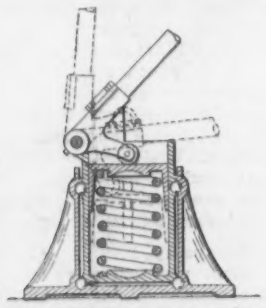
488,179. Trolley Stand for Electric Cars; Edward M Bentley, Boston, Mass. Application filed July 20, 1892. A trolley stand comprising an upright cylinder, a drum rotatable therein, a spring plunger sliding in the drum, and a trolley pole hinged to the drum, and having an arm bearing upon said plunger.

488,198. Electrical Distribution Box; William H. Hart, Brooklyn, N. Y. Application filed March 22, 1890. The combination, of the box having double walls with a space between them and coincident apertures in both walls below the edge of the box, the pipes passing through both walls, pipe securing devices and sealing material in the space between the two walls.

488,205. Lamp Socket and Terminal Therefor; Joseph Hutchinson, New York, N. Y. Application filed Feb. 8, 1892. The combination, in a socket of an insulating base, terminals carried thereby, each of the terminals, or either of them, being composed of two pieces adapted to grasp a part of said base, and a screw cooperating with said pieces and adapted to draw them together, substantially as described.

488,222. Incandescent-Electric-Lamp Base; Frederick C. Rockwell, Hartford, Conn. Application filed Dec. 26, 1891. A base for an incandescent electric lamp consisting of a bottom formed of a single piece secured to the globe, and bearing conducting pieces, and a shell formed of a single piece having two longitudinal chambers with one end closed, and the other secured to the bottom, with wire perforations through the closed end to each chamber also bearing conducting pieces, substantially as specified.

488,225. Railway Signal; Edmund Schaefer, Lynchburg, Va. Application filed Aug. 26, 1891. In a system of electric railway signals a pendent arm hung adjacent to the track where it can be struck by a projecting arm on a passing train, said arm hanging from a shaft carrying an insulated cam in combination with two pairs of spring terminal plates of two electric circuits, the plates being located on opposite sides of the cam, together with a spring for stopping the swinging of the arm by a train passing in one direction will close one of the circuits, and the swinging of the arm by a train passing in a opposite direction will close the other circuit.



No. 488,179.—Trolley Stand for Electric Cars.

488,233. Storage Battery; George Arthur Washburn, Cleveland, O., Assignor, by mesne assignments, to the Ford-Washburn Stor-electro Company, of same place. Application filed Dec. 10, 1889. In a secondary battery, the combination of perforated metallic electrodes separated by an interposed porous diaphragm, and insoluble active material permeated by an electrolytic solution, placed between and held in position by said diaphragm and electrode.

488,256. Process of Uniting Broken Pieces of Arc Light Carbons; Nathan P. Stevens, Concord, N. H. Application filed July 1, 1892. The process of converting fragments of electric arc light carbons into a homogeneous carbon of any desired length which consists in uniting the pieces by means of a paste composed of pulverized carbon and coal tar, mixed in about equal parts and applied hot, and baking the carbons until hard.

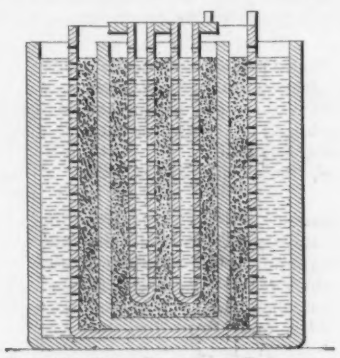
488,261. Dynamo Regulator; Charles J. Bogue, New York, N. Y. Application filed Feb. 18, 1892. In a dynamo electric machine the combination, an armature and an electro-magnet in the circuit of said dynamo of pole pieces movable circumferentially by an overload of current in the electromagnet.

488,285. Signal Repeater; Thomas H. Patenall, Rahway, N. J. Application filed Jan. 2, 1892. The signal repeating device comprising the separated magnets each in independent circuit, the swinging armature common to the two magnets, the visible signal supported to swing, an arm connected with the swinging visible signal, and having a loose engagement with the free end of the swinging armature, the yielding contact pieces having a normal tendency to rest in electrical contact, and the audible signal in circuit with the yielding contact pieces, the swinging armature being located between the yielding contact pieces, and when in its middle position free from pressure from either of the yielding contact pieces and adapted to engage one of the contact pieces just before it reaches the limit of its movement toward the magnet to which it is attached and thereby break the audible signal circuit.

488,299. Induction Apparatus; Charles Willms, Baltimore, Md. Application filed May 7, 1891. The combination with the battery circuit and an automatic circuit breaker, of a plurality of induction coils constructed to be thrown into or out of the circuit independently of each other, and controlled by said circuit breaker.

488,305. Electric Motor; Charles S. Bradley, Yonkers, N. Y. Application filed June 23, 1890. An alternating current electric motor composed of two opposite rotating members, each member comprising a circular series of electromagnets suitably mounted upon a shaft and divided into two separate circuits such that the magnets in one circuit alternate in position with those in the other circuit, and means for connecting the motor circuits with the supply circuits.

488,306. Alternating-Current Motor; Charles S. Bradley, Avon, N. Y. Application filed Mar. 15, 1892. A combination self-starting and synchronous alternating current motor having two circuits both connected to the supply terminals, the synchronous circuit being wound to offer at starting high counter-electromotive-force relatively to the self-starting circuit.



No. 488,233.—Storage Battery.

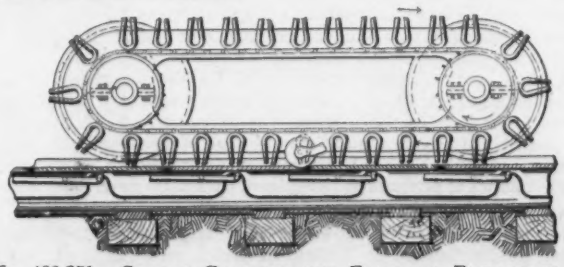
488,307. System of Distribution for Polyphase Alternating Current; Charles S. Bradley, Avon, N. Y. Application filed July 29 1892. The combination with a polyphase alternating current circuit of two or more lamp circuits connected in pairs with all of the polyphase wires, the lamp leads being distributed so that the several wires of the polyphase system will lie in near relation to each other, whereby a polyphase motor may be readily supplied.

488,329. Electric Arc-Lamp; Albert De Puydt, Liege, Belgium. Application filed Feb. 17, 1892. The combination in an arc light of a solenoid in a circuit about the carbons, carrying a stationary core and a movable core, the latter being suspended from two blade springs, and carrying contacts controlling the circuit including the feed regulating magnet.

488,351. Closed Conduit for Electric Railways; Leon O. Dion, Natick, Mass. Application filed Nov. 9, 1891. A magnet adapted to be pivotally connected to a fixed suport, so that its poles can rise and fall, and provided with off-set or upwardly extended poles and with an insulating support between said poles, as set forth.

488,367. Telephone; Pamell Rabbidge, Sydney, New South Wales. Application filed March 3, 1892. In telephone transmitters, a microphone consisting of granular or powdered conducting material such as granular carbon, confined between two metallic contact plates coated with a film of carbon on their faces next to the granular carbon, to minimize oxidation of said metal contact plates.

488,385. Guard for Telephones; Edward B. Chase, Philadelphia, Pa. Application filed July 30, 1892. A cap adapted to sheath the end of a telephone, the same being formed in sections and provided with a screw for connecting the sections and retaining them on the telephone.



No. 488,351.—Closed Conduit for Electric Railways.

488,388. Fire-Alarm Apparatus; Augustus G. Davis, Baltimore, Md. Application filed May 27, 1892. In an alarm operating mechanism, the hammer provided with the trip, in combination with the arms, and armature, magnet, catch, and the train of gearing, all substantially as and for the purpose specified.

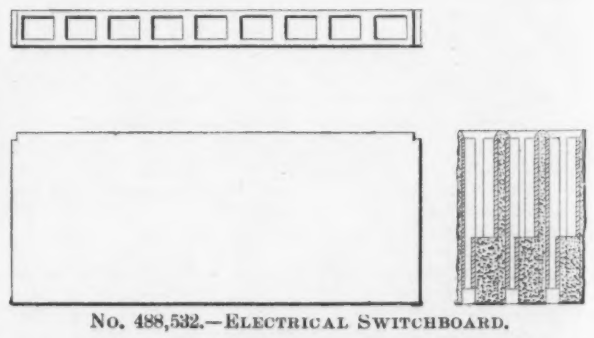
488,415. Means for Operating Station-Indicators; Reuben B. Ayres, New York, N. Y. Application filed Sept. 1, 1892. In means for operating station indicators of railway car systems, the combination with the trolley wire and trolley, and an automatic indicator located within a car, of electric contacts carried by the trolley, movable devices for closing said contacts from the trolley wire mechanically, and a suitable battery and wire connection.

488,466. Electric Forge; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass., Assignors to the Electrical Forging Company, Maine. Application filed Oct. 6, 1891. The combination of two rings constituting opposite poles of an electric converter, rigid conductors connected to said rings, clamps at the outer ends of said conductors, an electrode supported in one of said clamps, and consisting of a solid bar provided with a cup-shaped socket at its inner end and another electrode supported in the other clamp and consisting of a solid bar provided with a cup-shaped socket at its inner end, said electrodes being adapted to receive the opposite end of the bar to be heated.

488,467. Electric Metal-Heating Apparatus; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass., Assignors to the Electrical Forging Company, Maine. Application filed Aug. 8, 1892. The combination of a converter for converting electrical currents of high potential into those of low potential, conductors leading from said converter, and provided with metal heating appliances at a suitable distance therefrom, and a liquid bridge or short circuit contained in a metal reservoir, between the converter and said metal heating appliances.

488,468. Electric Metal-Working Apparatus; Geo. D. Burton, Boston, and Edwin E. Angell, Somerville, Mass., Assignors to the Electrical Forging Company, Maine. Application filed Aug. 31, 1892. In an electric metal working apparatus, the combination of a main circuit, a variable resistance disposed in said circuit, a branch working circuit connected with said main circuit, one terminal of said working circuit being provided with a work holder, and the other terminal with a movable holder having an insulated handle, and carrying a carbon pencil, and an electromagnet the core of which is disposed in proximity to said variable resistance for actuating the latter, the coil of said magnet being formed from one of the wires of the working circuit, and a wire connecting the core of said magnet with the work.

488,469. Electric Metal Heating Apparatus; George D. Burton, Boston, and Edwin E. Angell, Somerville, Mass., Assignors to the Electrical Forging Company, Maine. Application filed Sept. 22, 1892. The combination of the main circuit conductors, a high resistance tank having two terminal plates, one of which is connected with one of said conductors, a low resistance tank having two terminal plates, one of which is connected with the other main conductor, a short circuit conductor connecting the intermediate terminal plates of said tanks, and a working circuit having one of its conductors connected with the outer plate of one of said tanks and its other conductor connected with the inner plate of the other tank.



No. 488,532.—Electrical Switchboard.

488,482. Musical Instrument; Robert W. Pain, New York, N. Y., Application filed Dec. 4, 1890. The combination, with a pianoforte, of a number of electromagnets arranged within the same, and acting upon the keys thereof, electric circuit wires extending from said electromagnets and an apparatus at a distance from the pianoforte and connected with said electric circuit wires and comprising movable contact pieces, a coupling piece whereby the circuits may be disrupted, pneumatic motors for operating the contact pieces and a music sheet, card, tablet or roller comprising bellows for effecting the operation of the said pneumatic motors.

488,502. Telephone System; Charles C. Jennings, Chicago, Ill., Assignor to Charles H. Thompson and George A. Sheley, of Detroit Mich. Application filed Oct. 23, 1888. In a telephone system the combination with a series of stations connected with each other by a series of broken double circuits, each of which is closed through one of the two stations connected thereby, a battery and fixed telephone at each of said stations, and electromagnetic bells, included in the telephone loop circuit, of a portable telephone unaccompanied by a battery, adapted and arranged to close any one of said broken circuits at any point intermediate between said stations.

488,520. Electrically-Operated Stringed Musical Instrument; Willard H. Gilman, Boston, Mass. Application filed March 9, 1892. A stringed musical instrument, comprising in its construction a star wheel arranged in juxtaposition to the strings, an electromagnet and its armature, and actuating mechanism intermediate of the armature and star wheel for moving the latter.

488,532. Electrical Switchboard; James W. Lyon, Brooklyn, N. Y. Application filed June 11, 1889. An electric switchboard, composed of cards, each consisting of an insulating material molded about a series of pairs of contact plates forming a series of sockets.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

THE ELECTRICAL WORLD

AN ILLUSTRATED WEEKLY REVIEW OF CURRENT Progress IN Electricity AND ITS PRACTICAL APPLICATIONS

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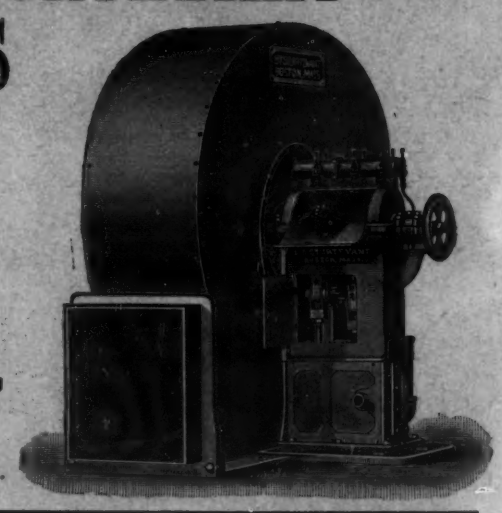

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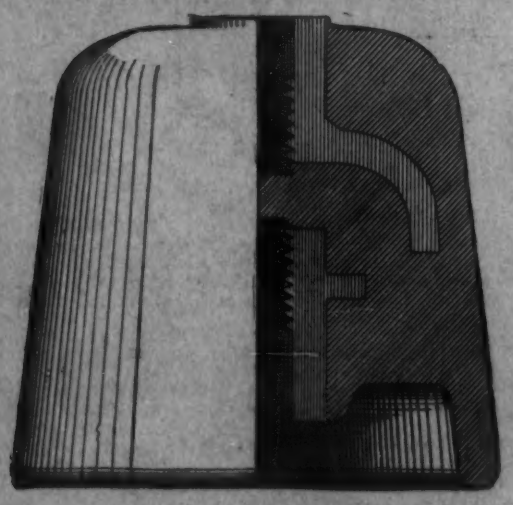

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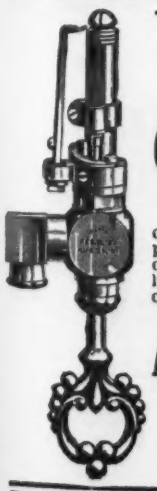

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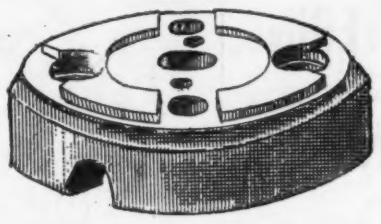

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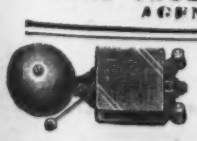

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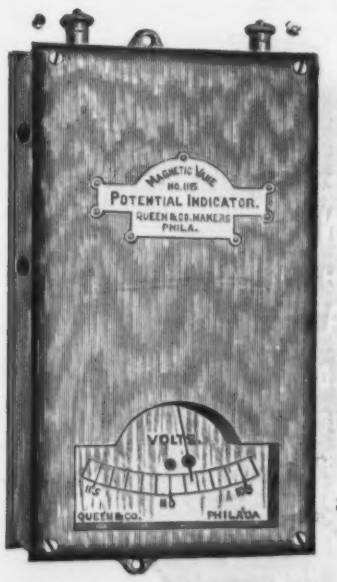

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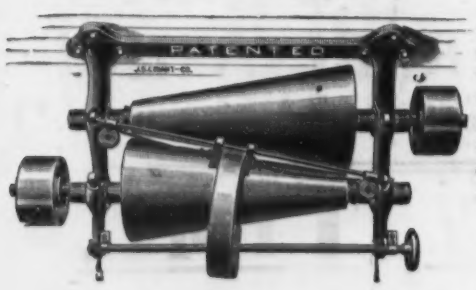

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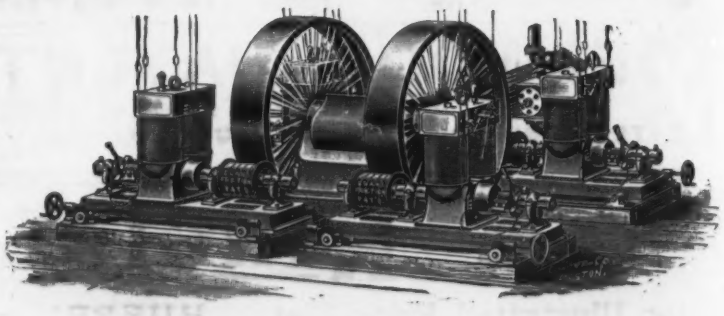

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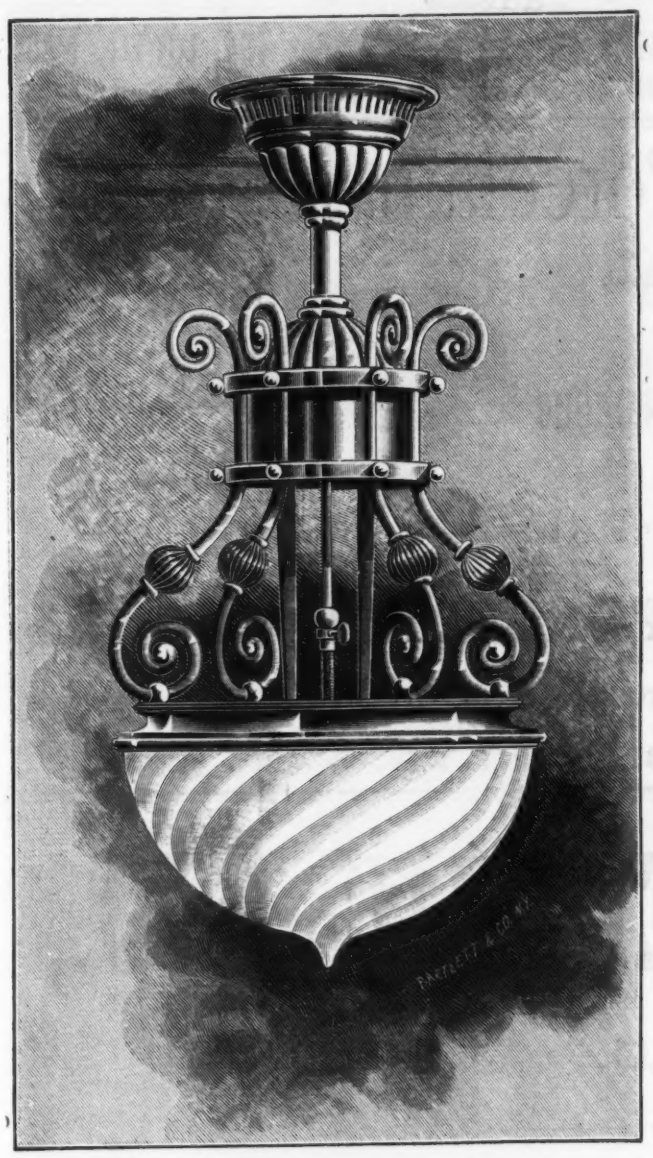

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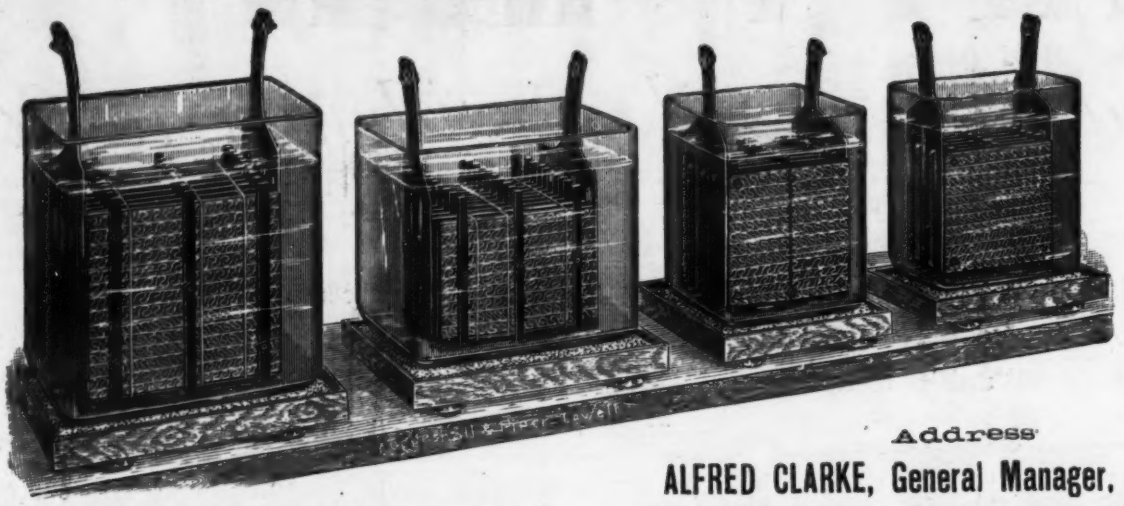

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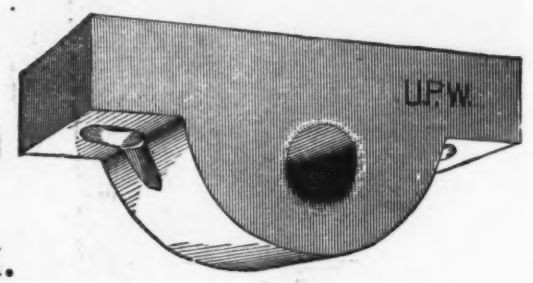

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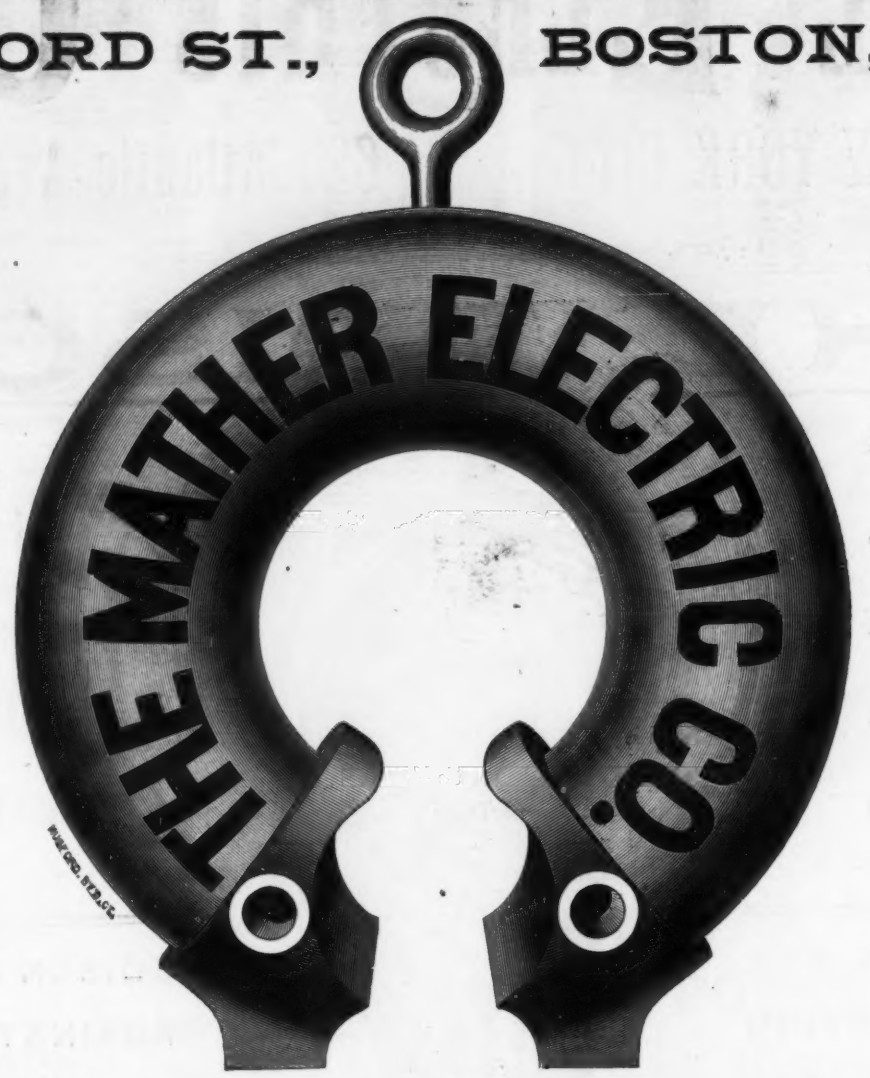

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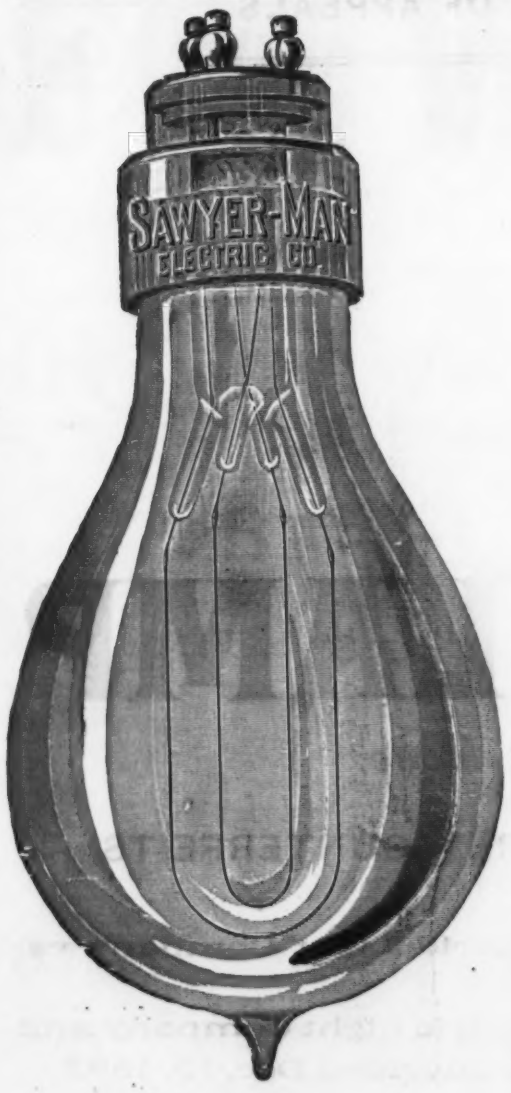

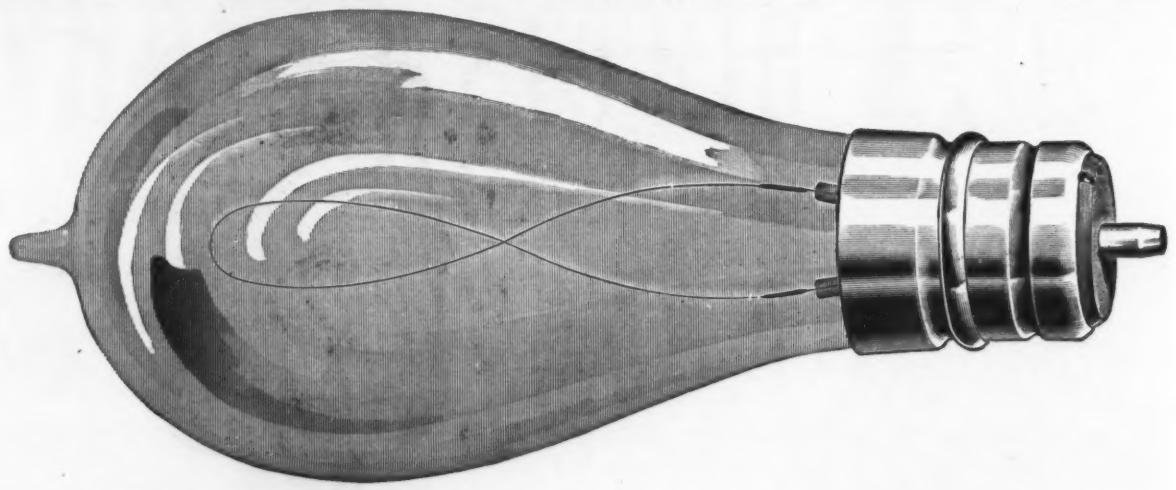

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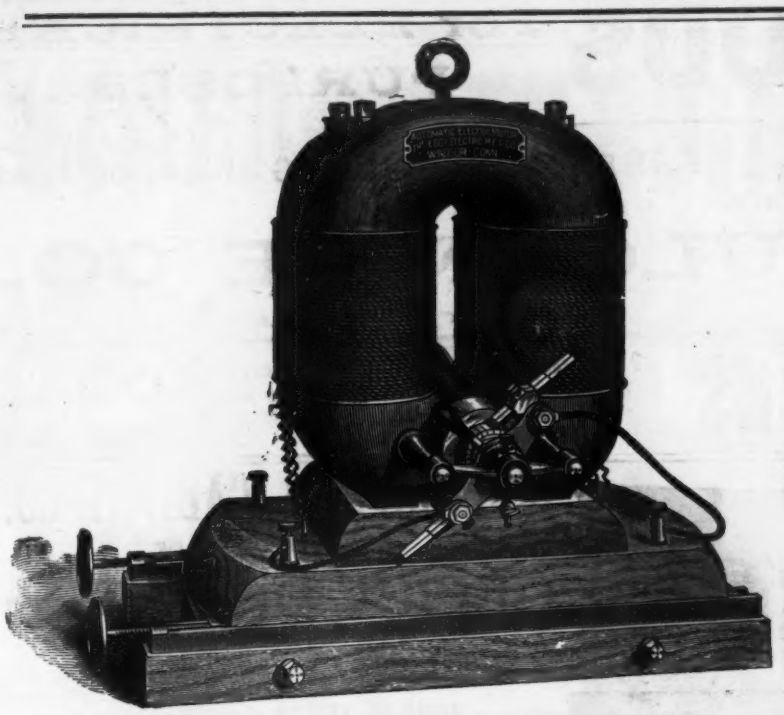

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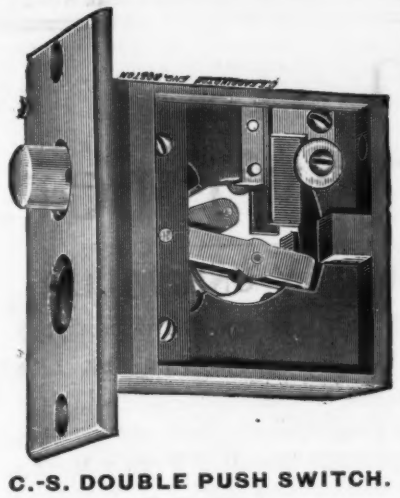

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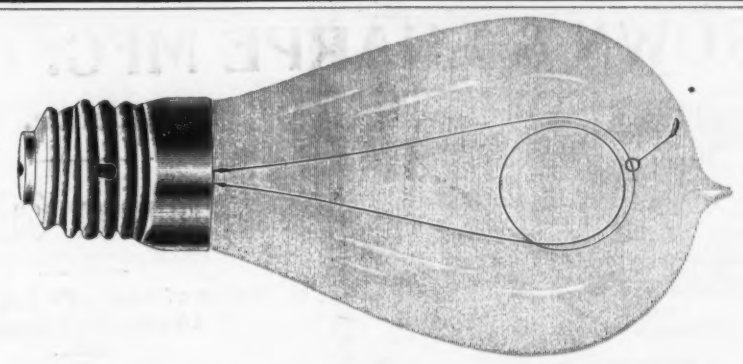

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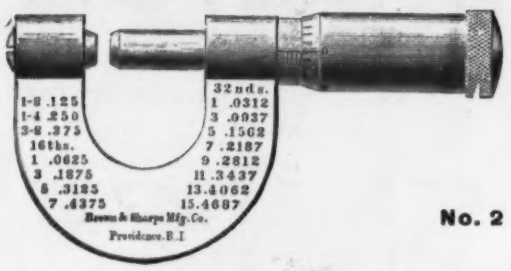

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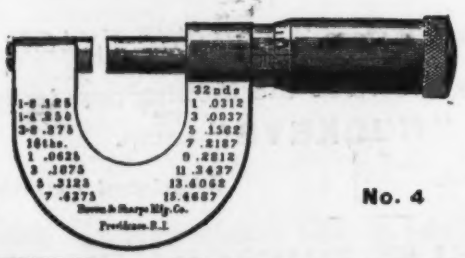

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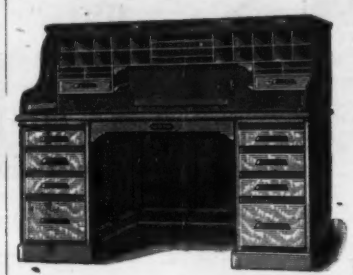

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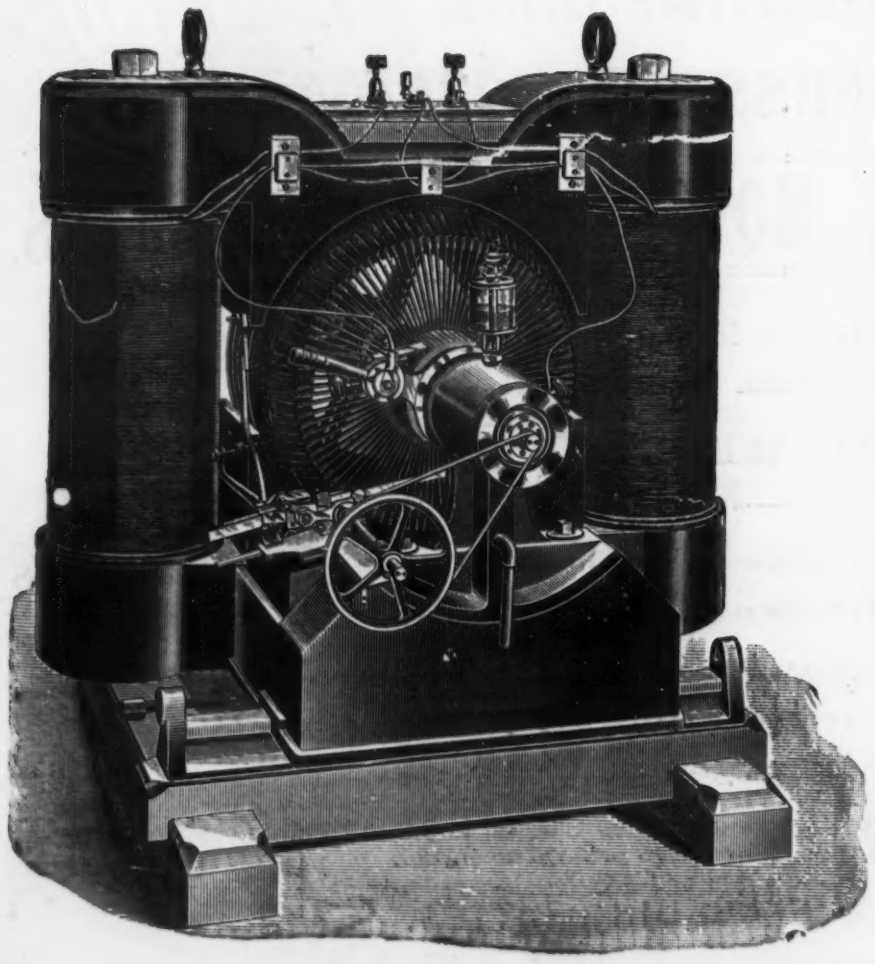

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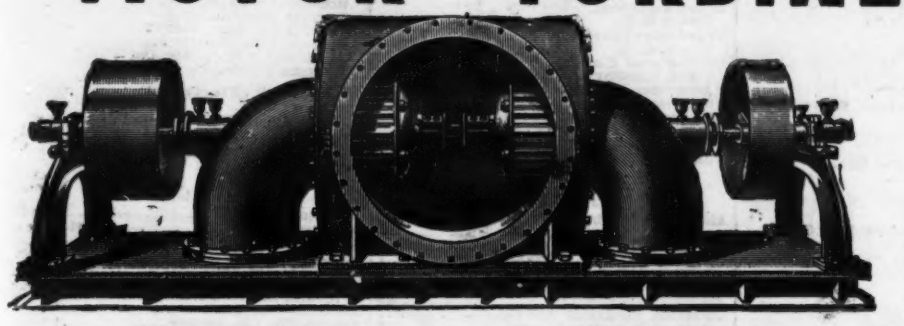

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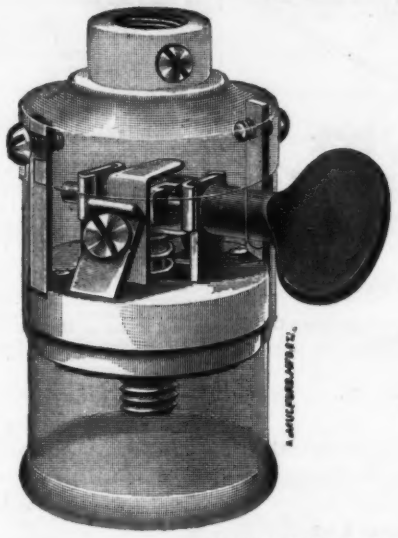

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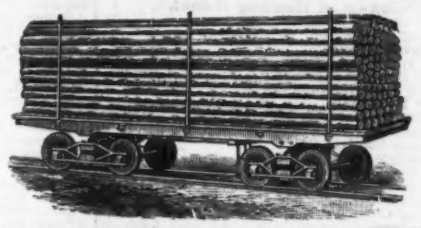

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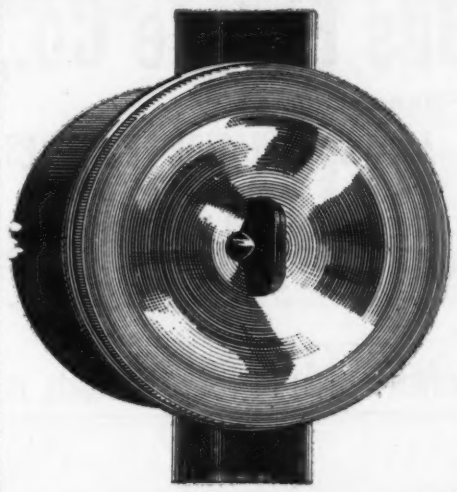

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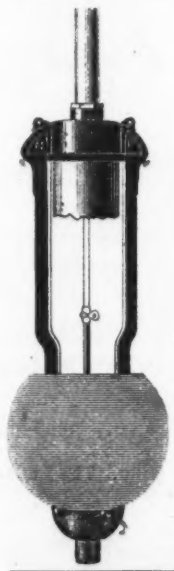

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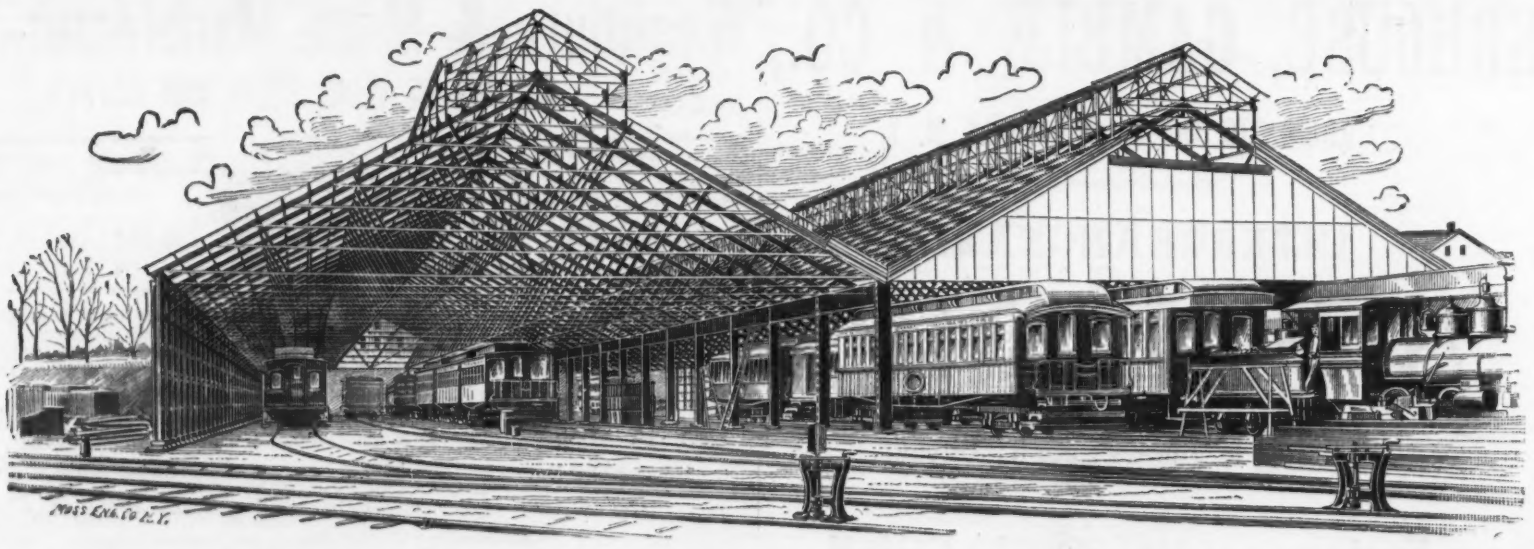

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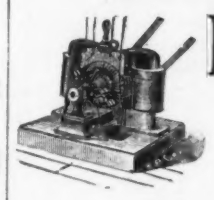

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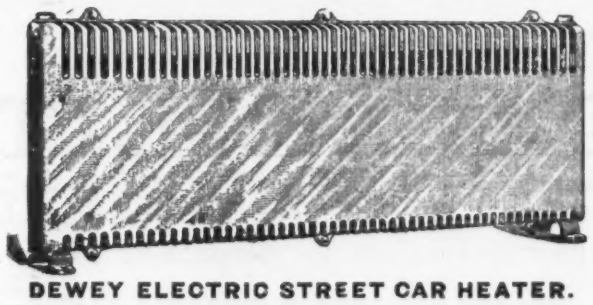

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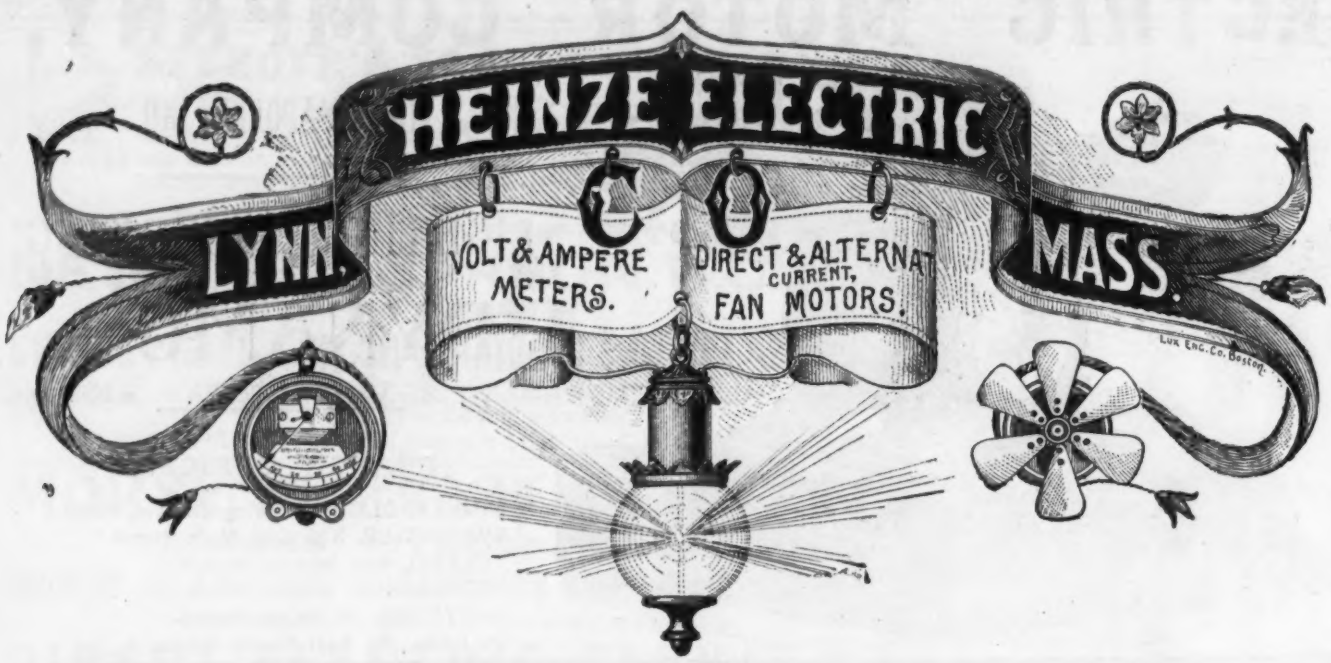

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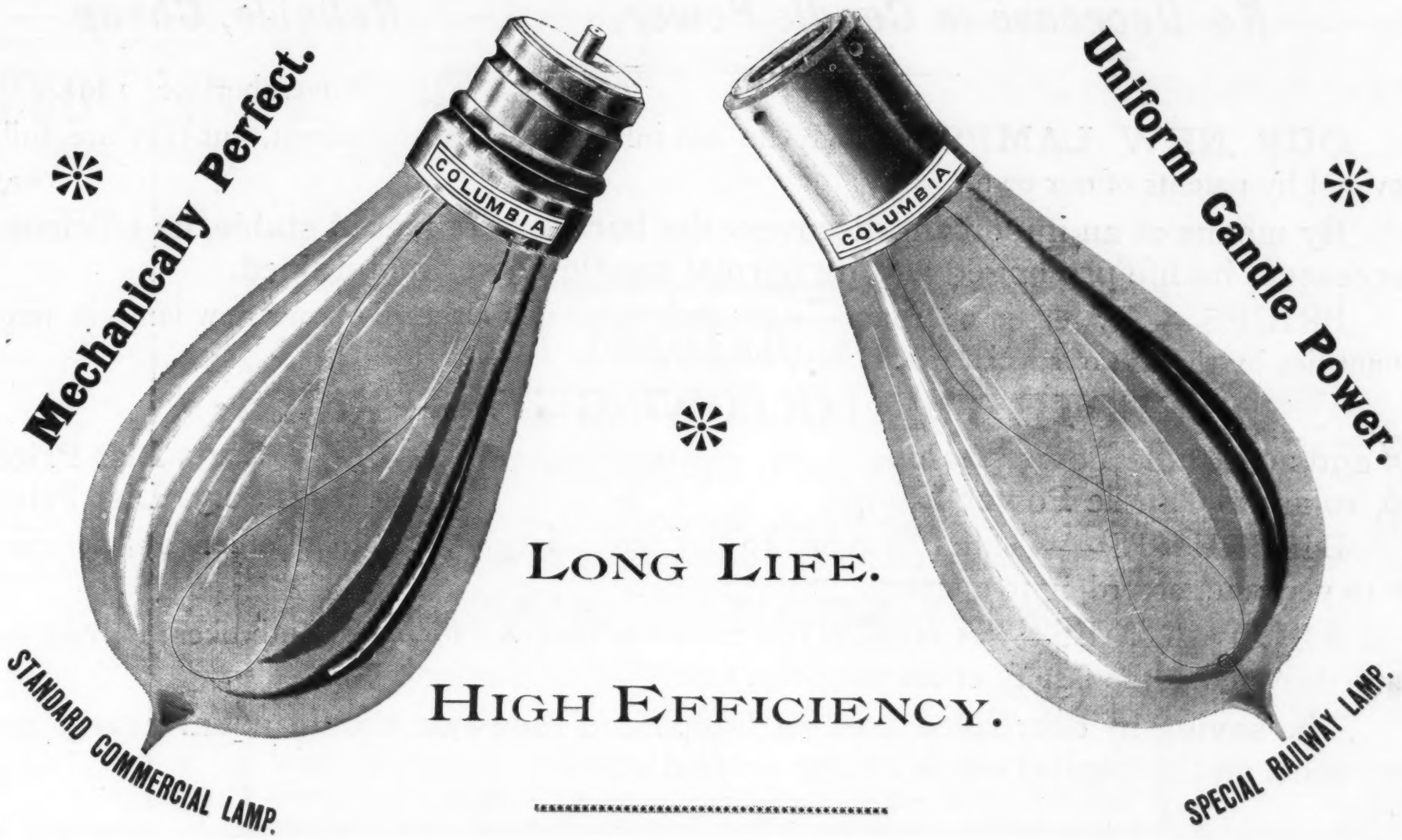

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We have also been informed that one other company had executed Form D contract of the General Electric Company. These three are the only instances we have discovered, where they have succeeded in doing business in the direction of inducing users of our apparatus to discard it for apparatus made by members of the Trust.

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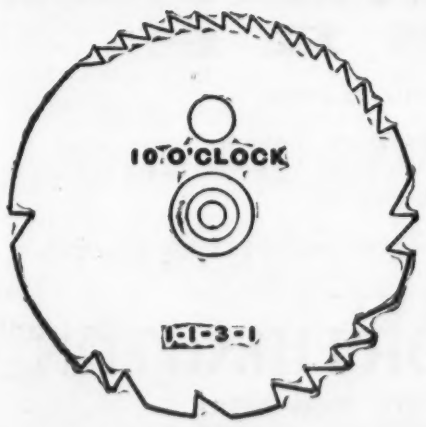

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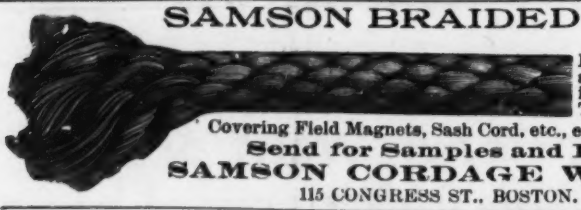

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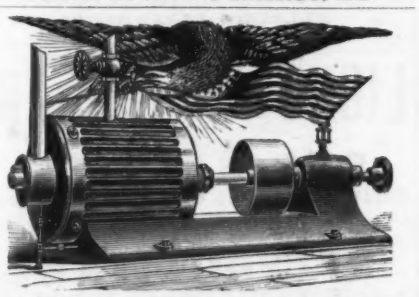

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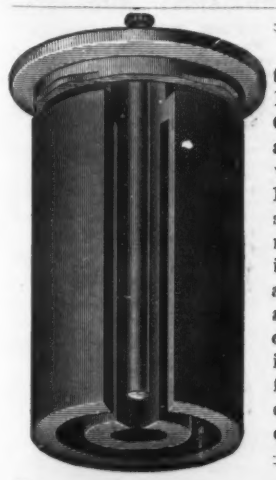

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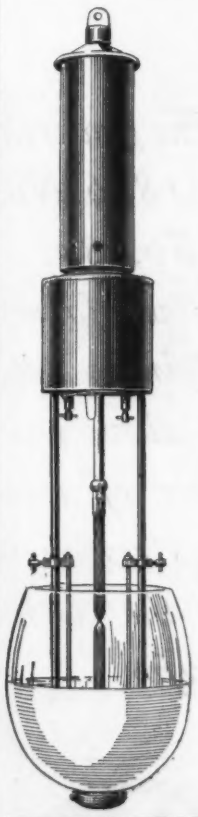

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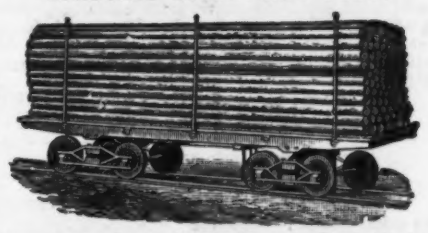

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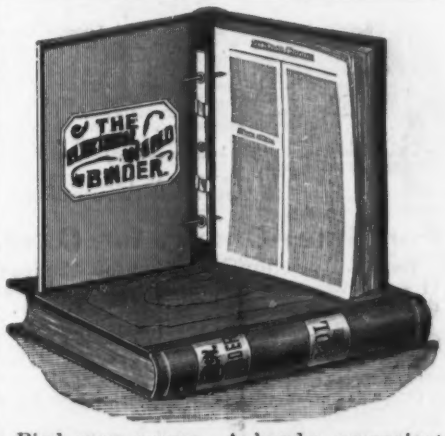

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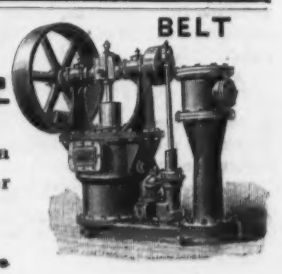

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One	18	"	12	"	"	" "
One	18	"	8	"	"	" "
One	18	"	6	"	"	" "
One	9½	"	10	"	Excelsior	" "
One	9½	"	8	"	"	" "
One	9½	"	30	"	Brush	" with
One	9½	"	5	"	"	" no
One	9½	"	25	"	Ball	" "
One	18	"	30	"	West'n Elec.	" with
Three	18	"	35	"	"	" "
One	9½	"	40	"	"	" "
Two	18	"	20	"	U. S.	" "
One	18	"	30	"	Jenney	" "
Two	18	"	16	"	"	" "
One	9½	"	20	"	American	" no
One	9½	"	50	"	"	" "
One	9½	"	40	"	Sperry	" with
Two	18	"	20	"	"	" "

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Two hundred	9½	amp.	single Waterhouse lamps.	
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Fifteen	6½	"	single Brush	" No. 16
Sixty-nine	9½	"	" "	" No. 10.
Forty-three	9½	"	" "	" No. 18.
Ninety-seven	18	"	double Jenney	"
Eighty	9½	"	" Brush	" No. 11.
Fifty	18	"	single Jenney	"
Sixty	18	"	double Western Electric lamps.	
Forty-three	18	"	single "	"
Two hundred	18	"	double Van Depoel	"
Forty-five	18	"	single "	"
Fifty-four	9½	"	" Excelsior	"
Five	9½	"	double "	"
Twenty	9½	"	single Ball	"
Forty	18	"	" Sperry	"
Thirty-five	9½	"	single American	"
Fifty	9½	"	double "	"

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One	110	"	750	"	" dynamo	" rheostat.
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One	96	"	450	"	Brush "	" "
One	96	"	300	"	" "	" "
Two	4	amp.	300	"	Heisler "	" regulators.
Two	4	"	500	"	" "	" rheostat.
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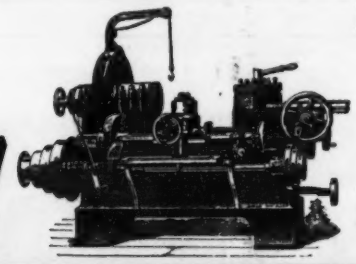

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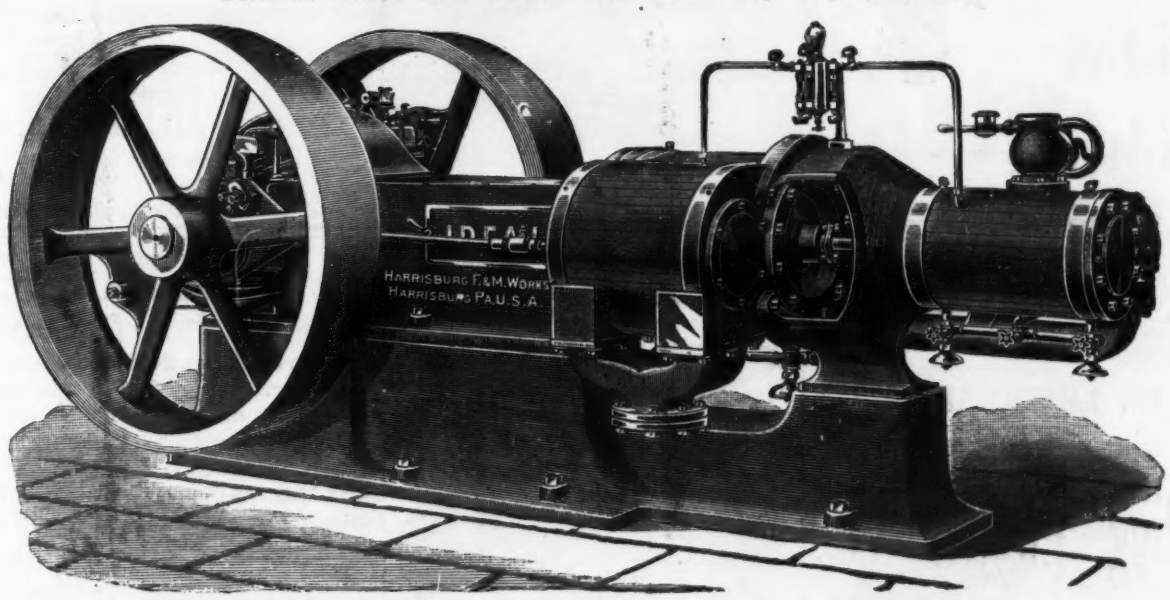

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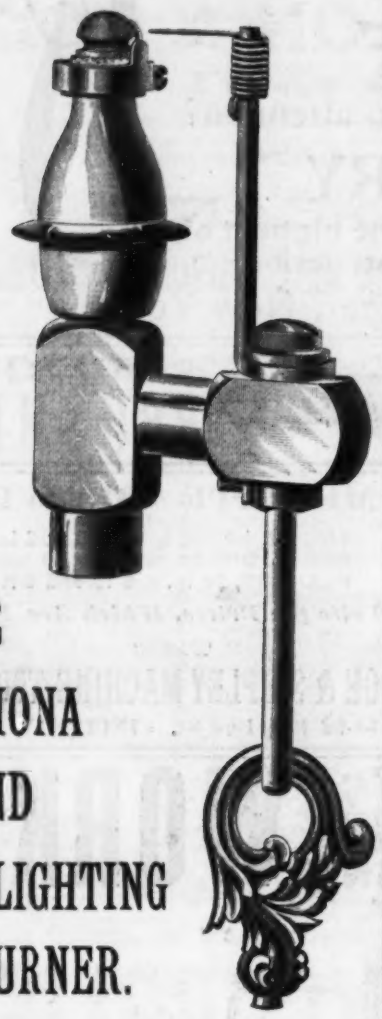

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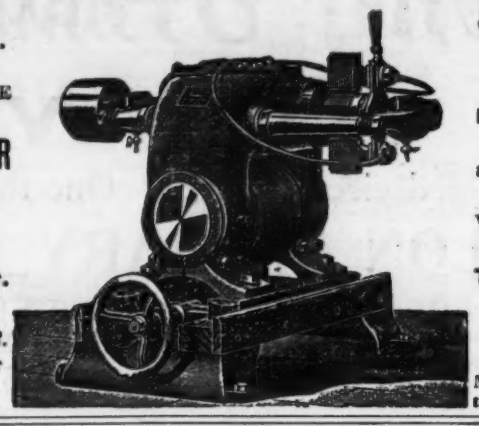

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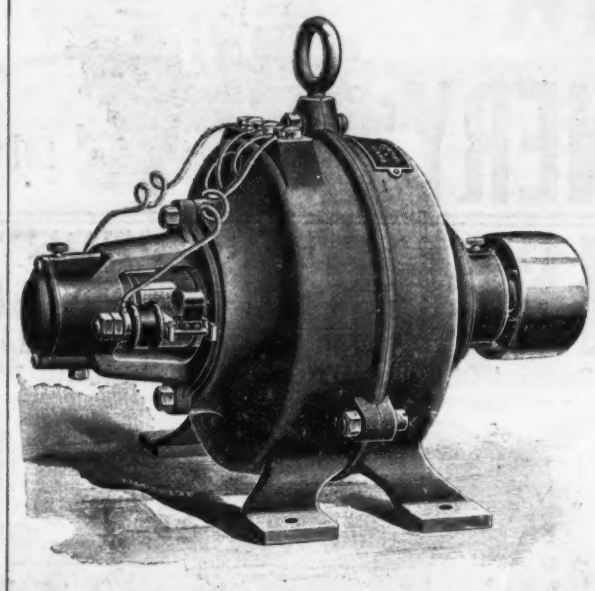

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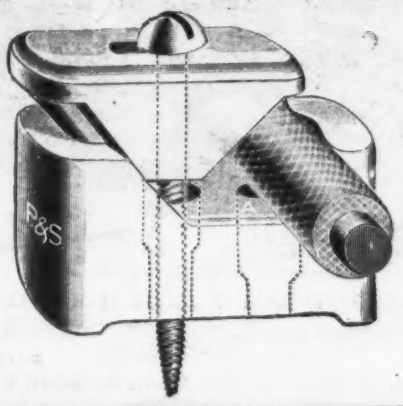

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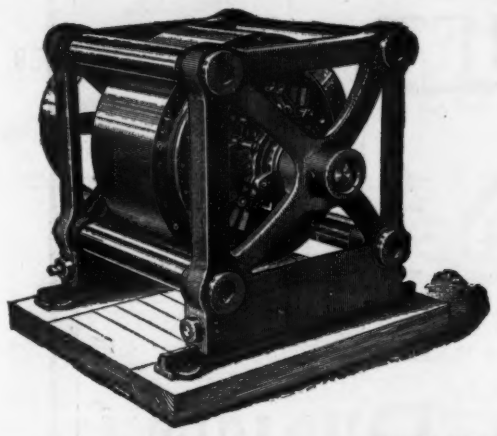

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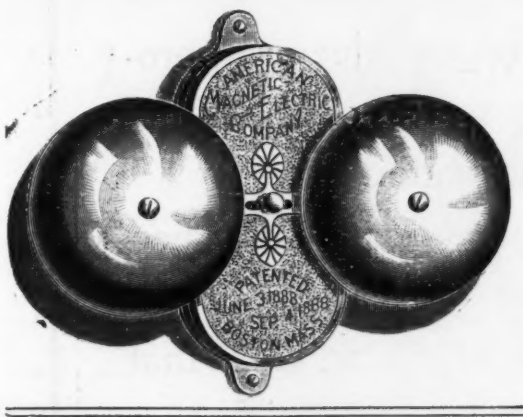

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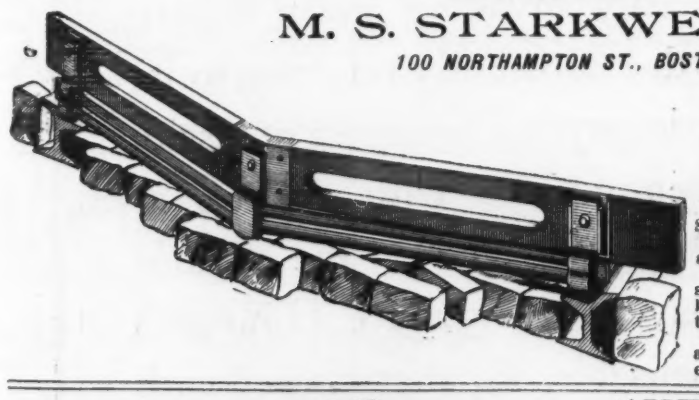

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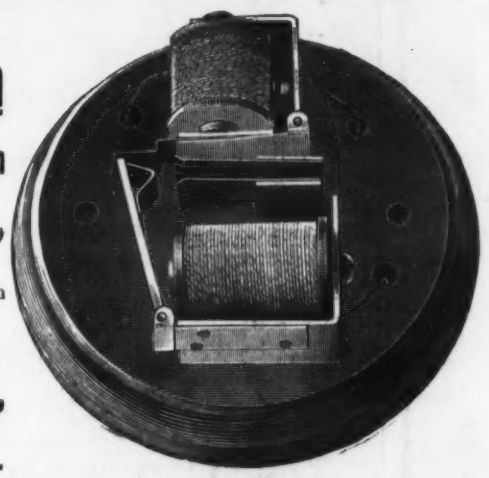

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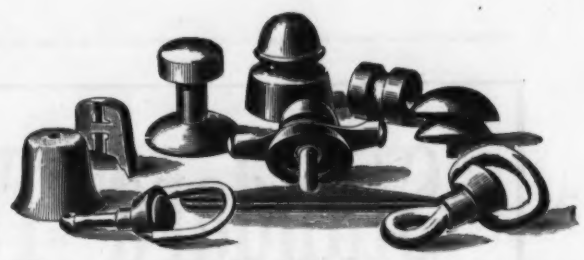

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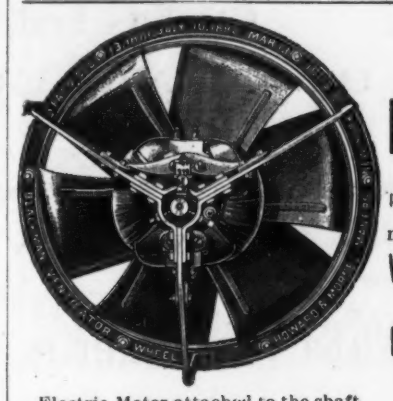

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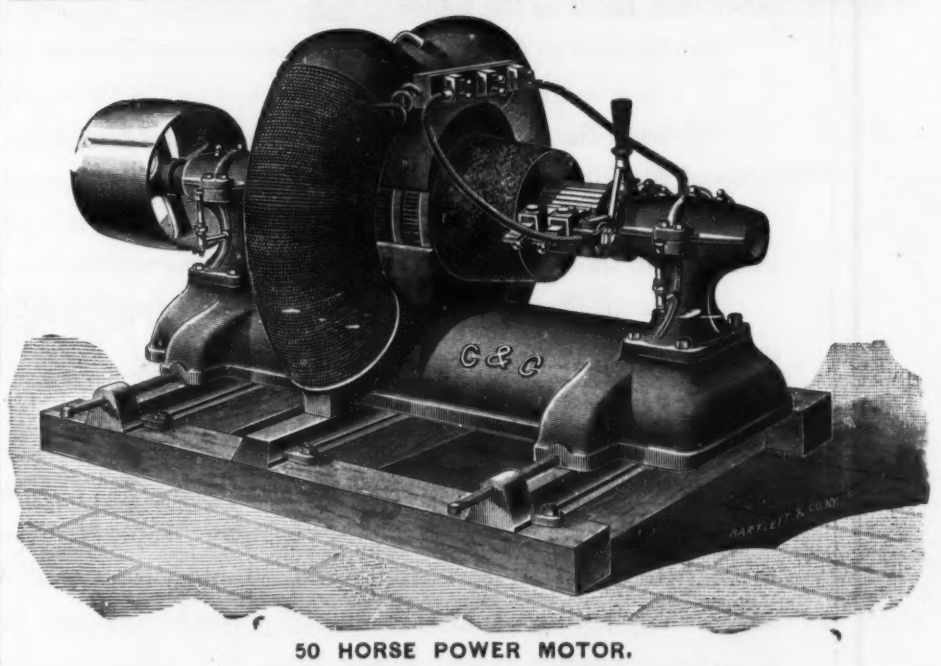

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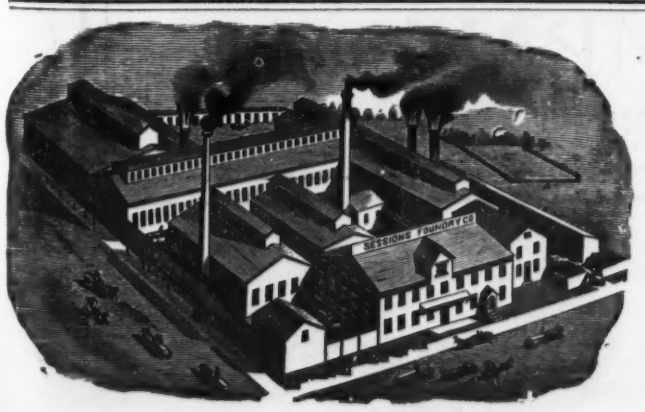

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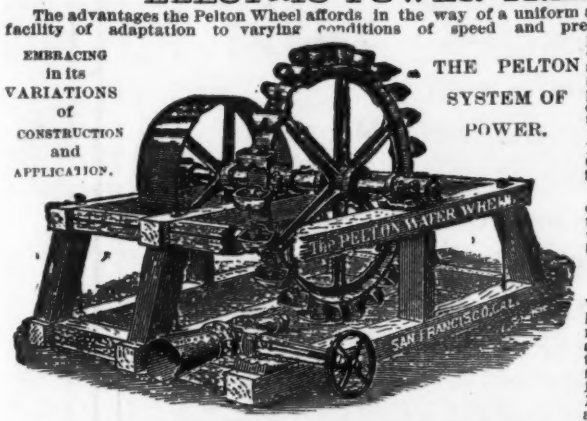

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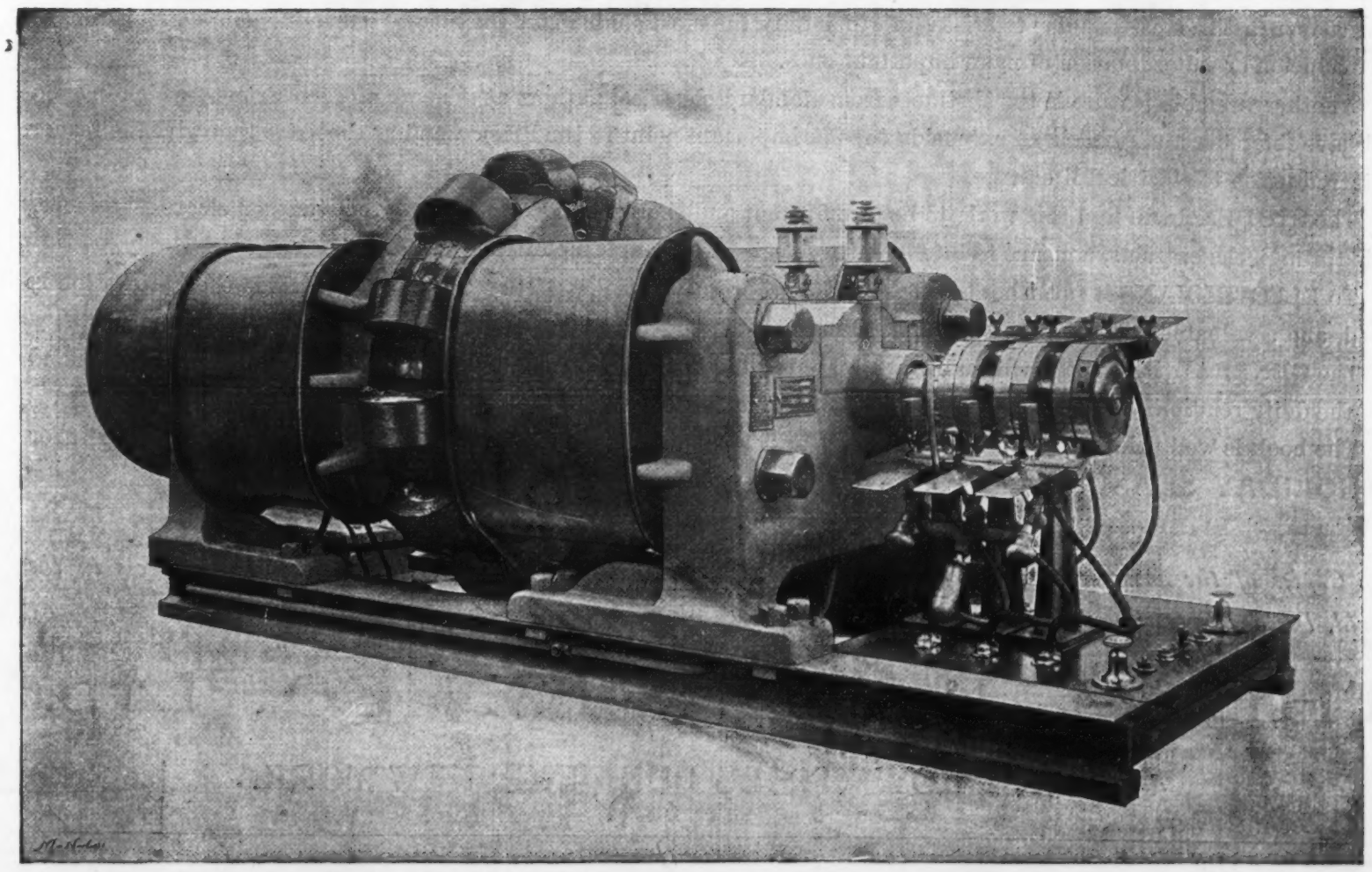

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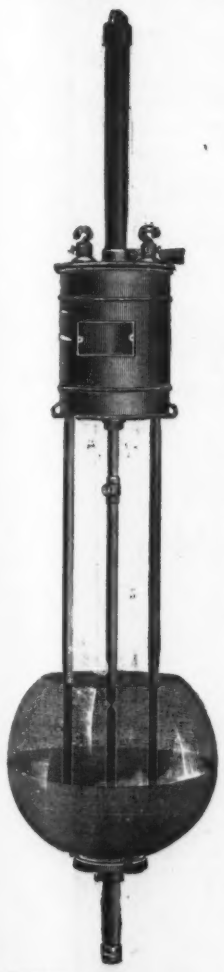

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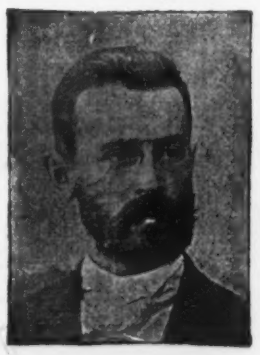

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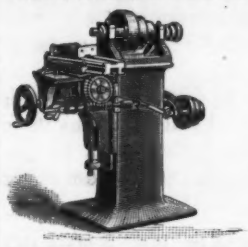

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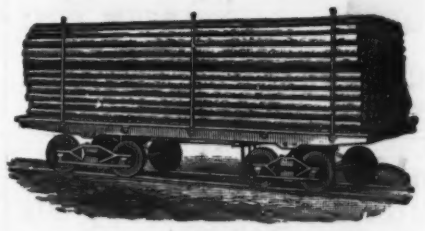

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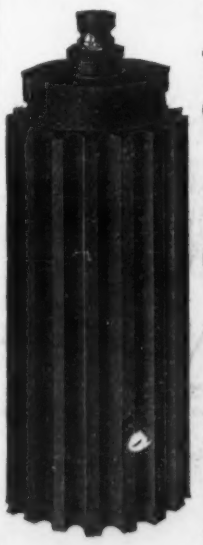

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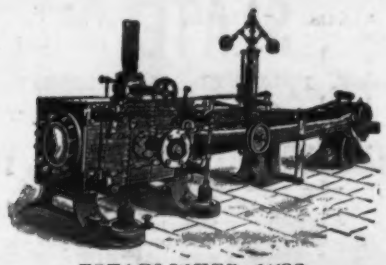

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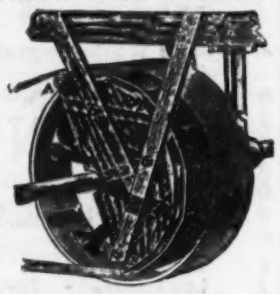

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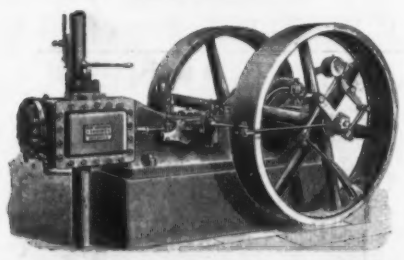

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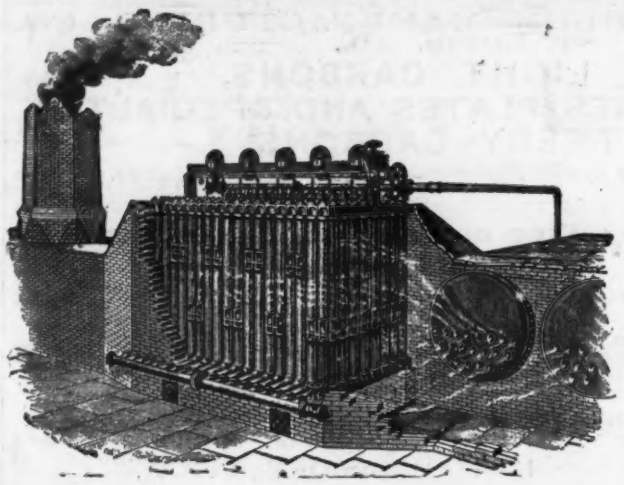

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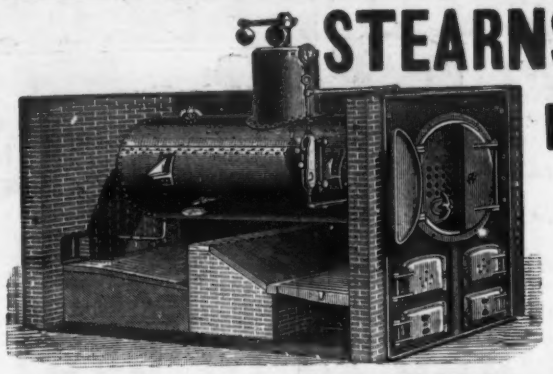

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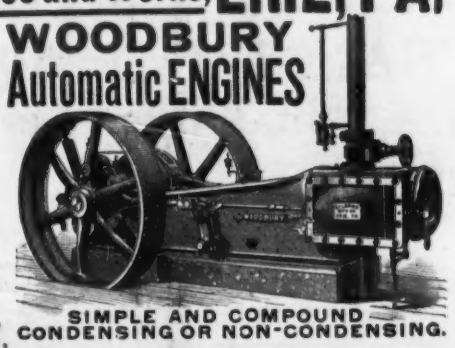

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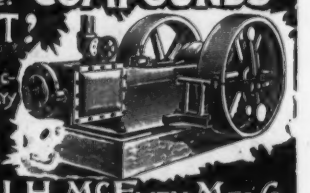

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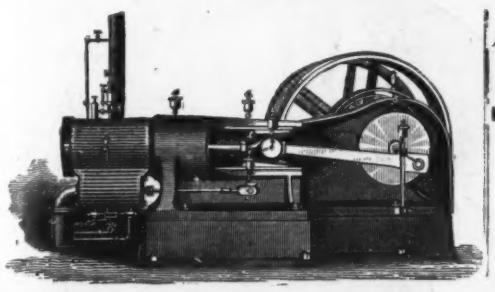

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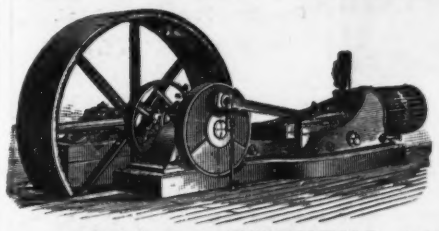

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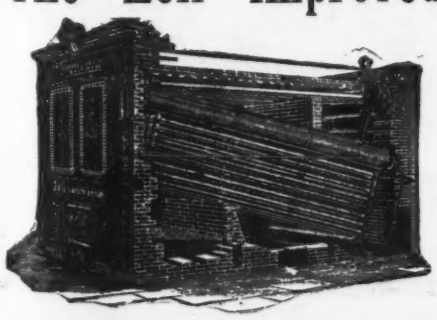

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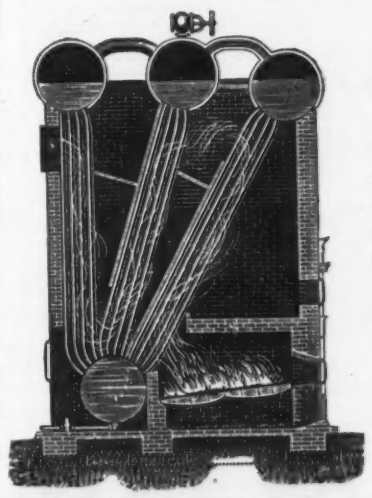

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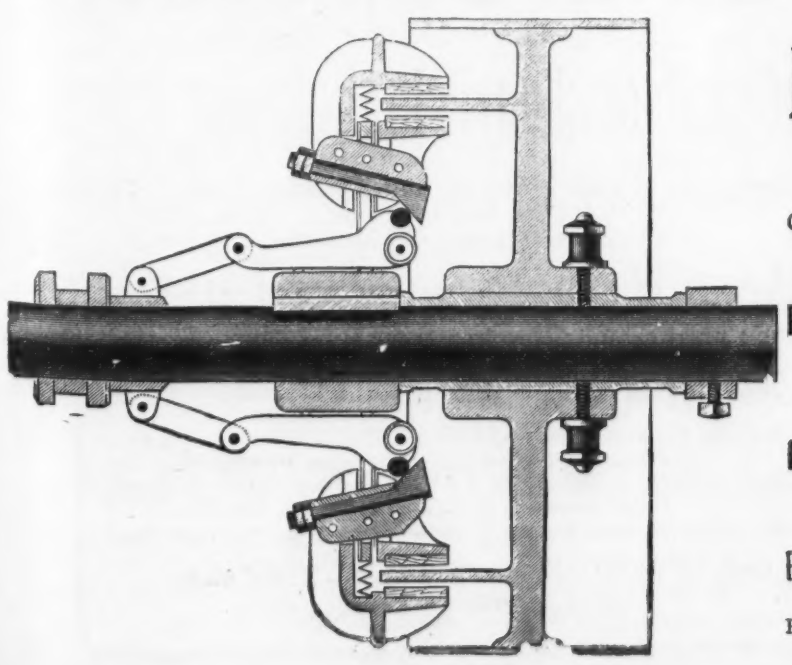

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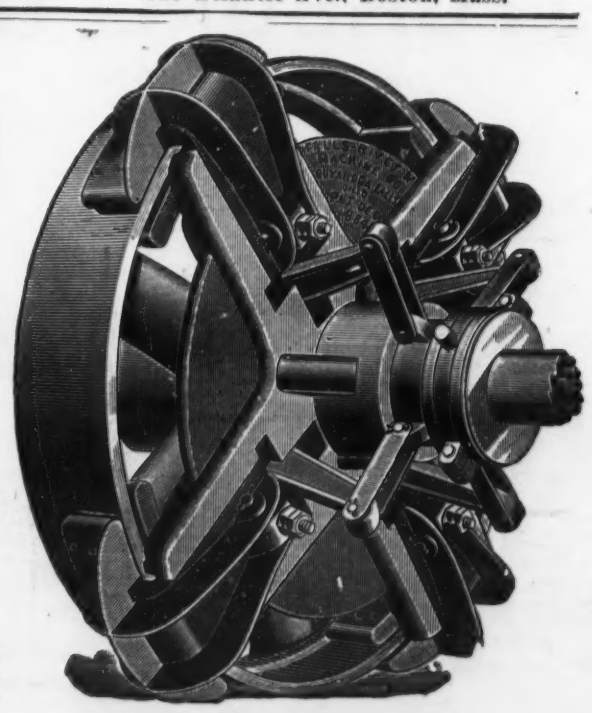

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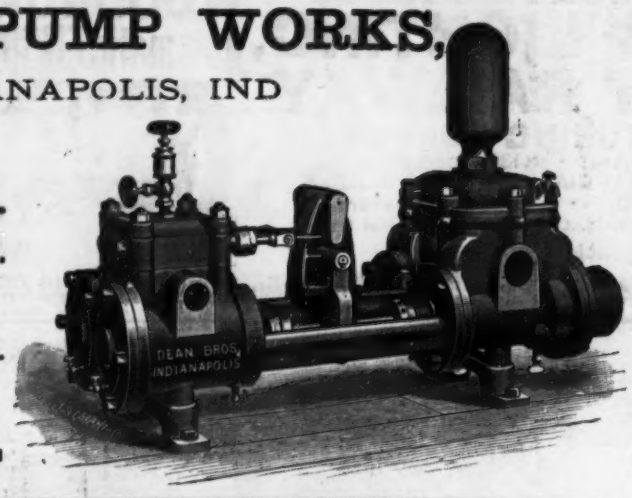

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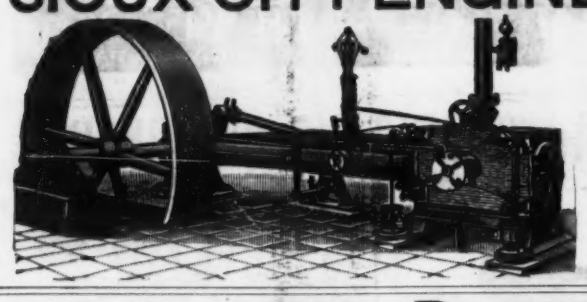

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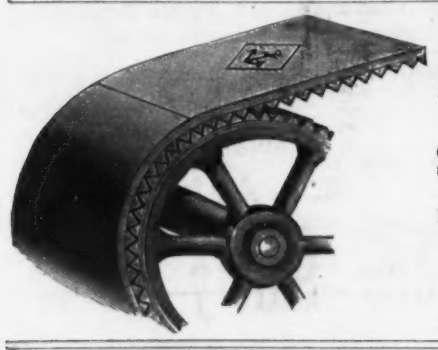

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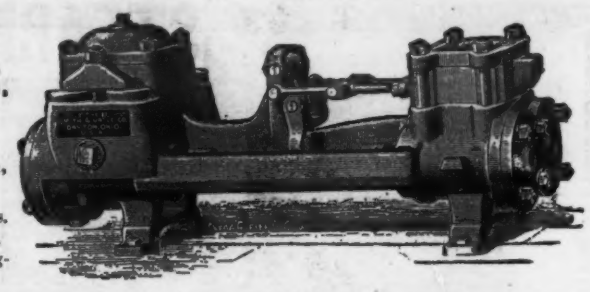

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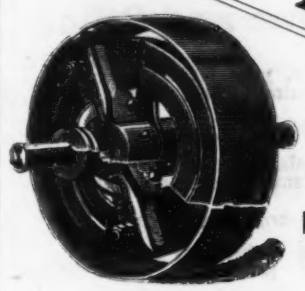

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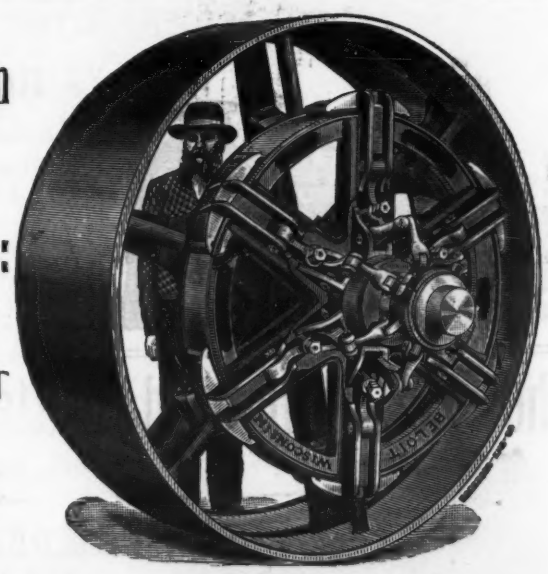

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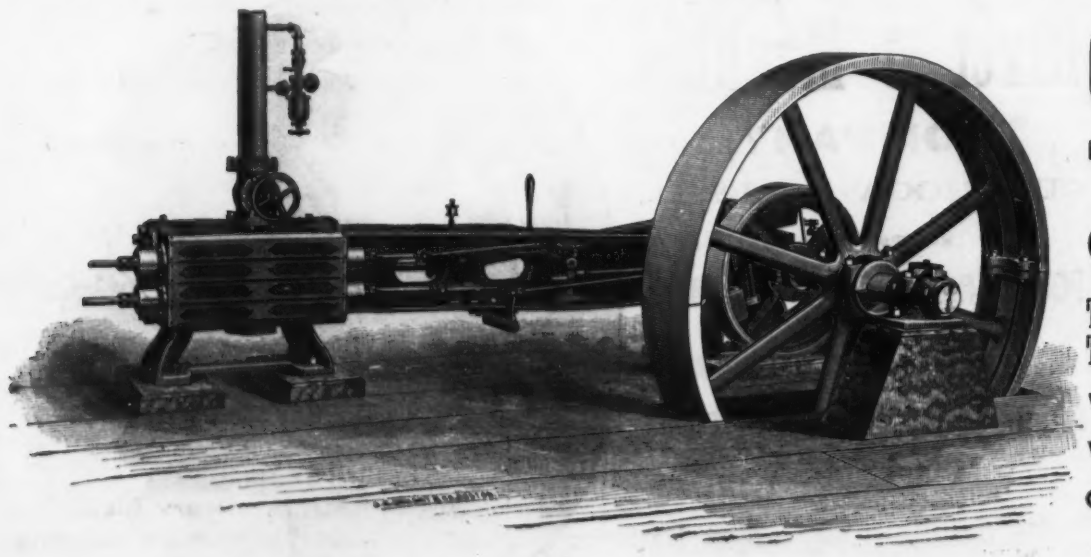

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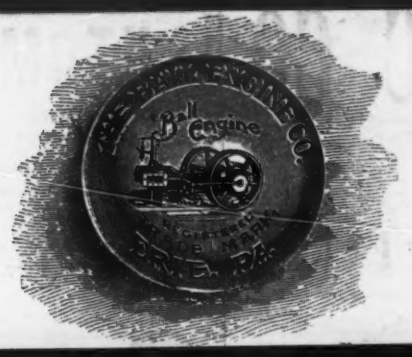

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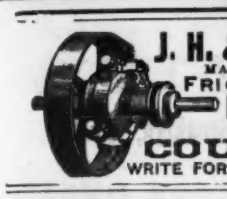

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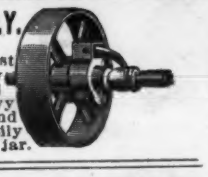

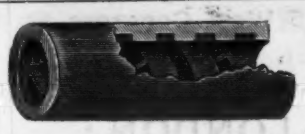

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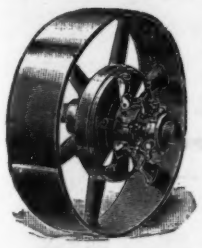

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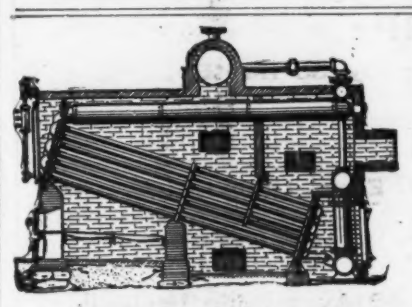

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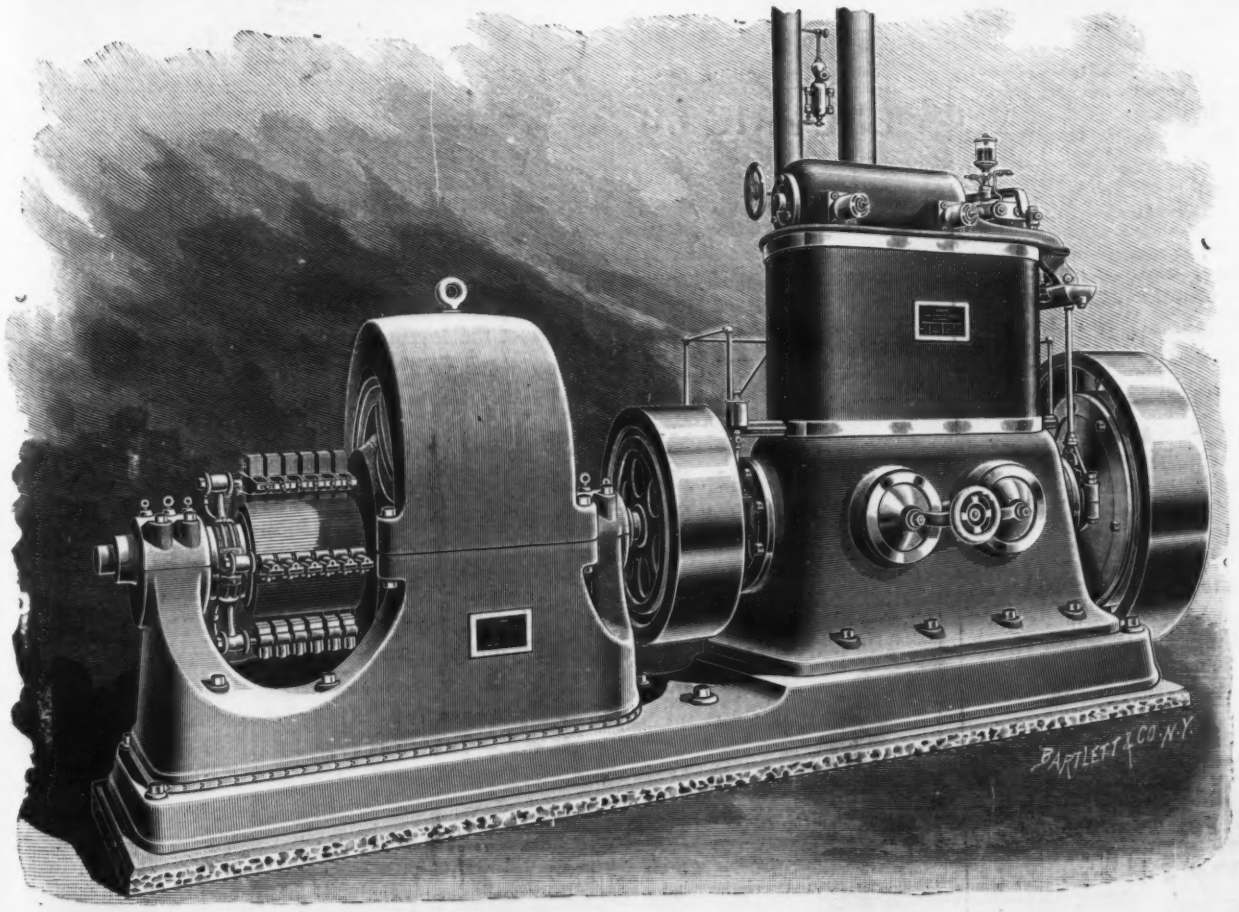

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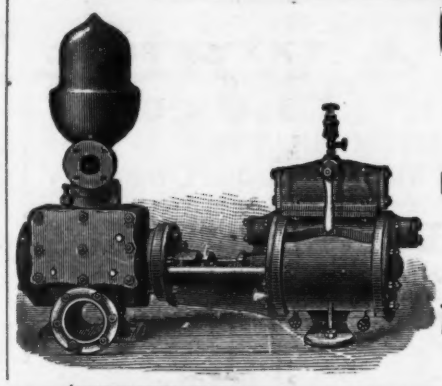

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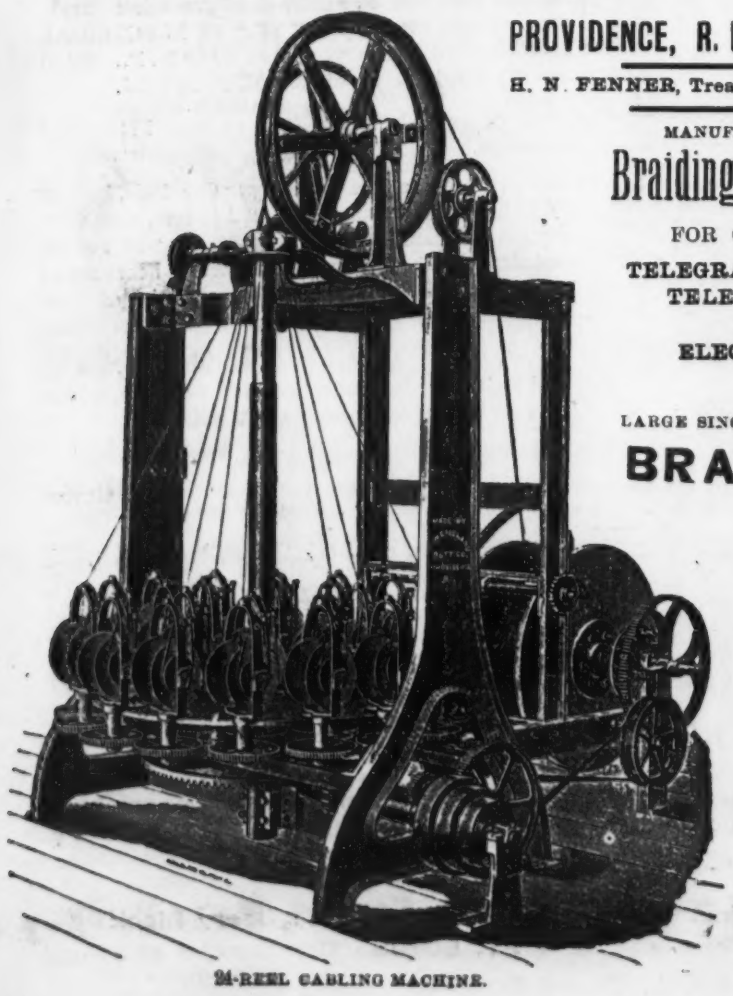

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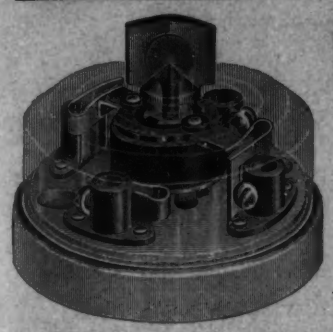

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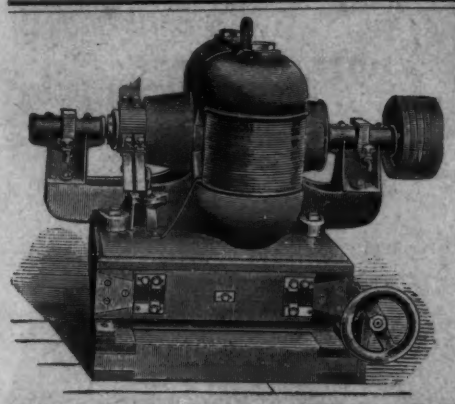

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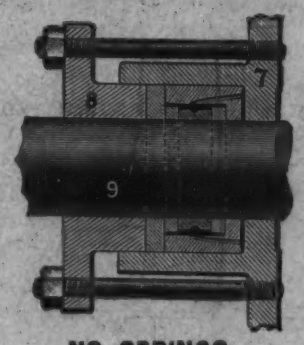

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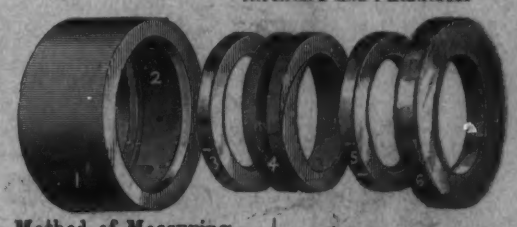

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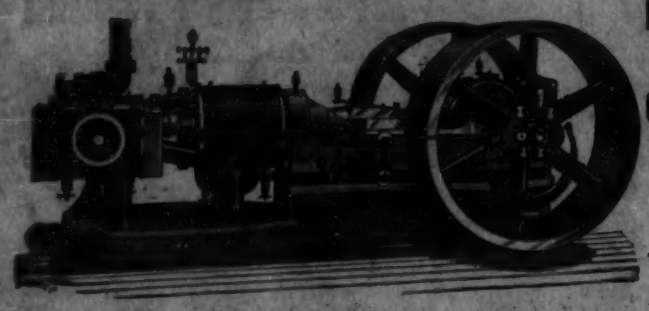

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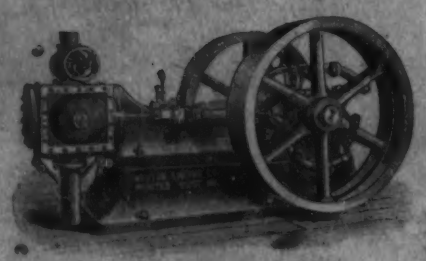

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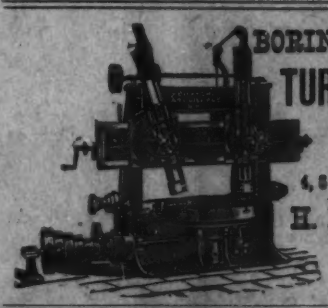

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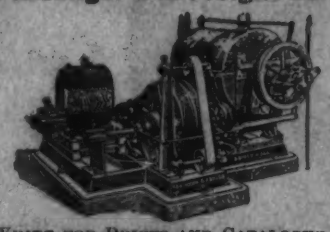

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